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The Aviation Consumer

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CAN WORKHORSE REINVENT THE HELICOPTER?

For the past few years, the Innovation Center at AirVenture is the place to visit if you're even slightly interested in electric mobility, flying cars and UAVs. Sure, it's a place for dreamers but dreams spark reality, I suppose. This year while doing a video shoot there on the Workhorse SureFly helicopter/VTOL (vertical takeoff and landing) personal aircraft, it was obvious that some of the dream machines are getting bigger—as in big enough that people would actually fly in some of them. The majority in the steady crowd of onlookers waiting in the long line to climb into the sleek SureFly seemed like they would and that's a good sign for market acceptance. The publicly traded Ohio-based Workhorse Group, which builds electric trucks for customers including UPS, FedEx, Brinks and Ryder, to name a few, is going big and steering clear of a too-radical design with its octocopter because it thinks it is time to reinvent the helicopter.

The SureFly's project manager, Patrick Connors, reminded me of the helicopter's 78-year design run and matter-of-factly described what he thinks are the three main reasons there needs to be a replacement. "Helicopters as we've known them for 78 years are expensive to purchase, expensive to maintain and they make a lot of noise," Connors told me standing in front of the SureFly, which to my eyes somewhat resembles a futuristic Schweizer 300-series piston helicopter, but with a much larger cabin. Connors wasn't proclaiming anything we don't already know. Plus, electric motors could be the answer to cutting cost, complexity and noise, which is partly what is giving the SureFly project some legs, or at least skids. The other key is simplicity. The SureFly has no wings, tail, tilt rotor or tilt wings, plus the props are fixed-pitch with no transitional parts.

The SureFly machine on display had a 2.0-liter four-cylinder Honda engine (likely not the final production powerplant) connected to two 100-kW redundant generators. The generators make electricity for the independent three-phase AC drive motors, of which there are eight, each connected to its own carbon fiber propeller. There are two propellers per arm, which are contra-rotating. The idea is to independently control each motor, which allows precise control of the pitch and yaw axes. If you're thinking the machine sounds like a large-scale drone, that's exactly how Connors labeled the overall design—except it's on a much larger scale. The four arms, which sit atop of a spacious two-seat carbon fiber cabin, can be folded down so the machine can be stored in an average-sized garage. The SureFly is spec'd to have an 1100-pound curb weight and a 1500-pound takeoff weight. The current payload is around 400 pounds, but the goal is to bump that up to 500 pounds. With a ceiling of 4000 feet, Workhorse says this is a short-hop machine and is planning on a 70-mile range and one hour of endurance per each tank of fuel. The top speed should be around 75 MPH. The target price is $200,000 (the company is collecting $1000 position deposits) and the target market is diverse, including precision agriculture, emergency responding, city commuting and military applications, plus there's package delivery and personal flying.

"The beauty of generating your own electricity is once you land, you don't have to plug it in. Just refill the generator's gas tank," Connors said. There is no single point of failure. If the gasoline generator fails, the ship has dual lithium battery packs good for five minutes to make a powered emergency landing, plus it has a ballistic parachute. No stranger to drones, Workhorse invented the UPS delivery drone, a project that company CEO Stephen Burns said is progressing through the FAA approval stages.

But since the SureFly octocopter is manned (flown autonomously and manually), I think FAA certification will be a huge challenge, especially as it figures out what credentials you'll need to fly it. The company plans to begin flight testing this year, with a lofty goal of FAA certification by 2019. —*Larry Anglisano*

PULSE OXIMETER ARTICLE AND THE FAA'S PROTE

Great article on pulse oximeters in the September 2017 issue of *Aviation Consumer*. I have been using them for almost two decades and keep one in my turbocharged Bonanza and another in my glider.

I routinely fly in the teens and I always insist that passengers use the pulse oximeter every half hour or so just as I do.

The cheaper models seem to work as well as the more expensive models, as you found, but two comments should be added. First, some smartphones do just as good a job. My Samsung Galaxy S7 is one example. It has a pulse oximeter feature and many other health monitoring metrics. I found that it calibrates very well against my two dedicated pulse oximeter units and it records the readings over time.

Also, I want to pick up on what you wrote about the NTSB records and the lack of credible data on how serious the hypoxia safety issue is. From soaring in the West, where altitudes are almost always in the teens, I can recall a long list of accidents where a very experienced and careful pilot got into trouble and/or died due to bad piloting with no apparent reason for the lapse in good judgment. I have a hunch that the issue is vastly understated as a safety issue, as you indicate.

I would suggest you strongly recommend your readers sign up for an altitude chamber "ride" to get to know their personal symptoms and tolerance for hypoxia. The FAA has a new traveling road show called PROTE. I wrote a complete article about it in a recent *Soaring* magazine. It is a small office-type structure that can hold about eight trainees and instead of reducing pressure to emulate 25,000 feet MSL as do the full-on pressure chambers, it replaces much of the oxygen in the air with inert nitrogen to simulate 29,000 feet MSL with respect to available oxygen in the air. The portability of this device makes it attractive for offering it all around the country, but it has a serious downfall, in my opinion. The ride lasts just five to six minutes due to being instantly immersed in extreme hypoxia conditions at 29,000 feet. For flying in small unpressurized planes, the much greater risk is the insidious onset due to failed supplemental oxygen equipment, or the belief that you are only in the teens of altitude and don't need to worry.

The other limitation of the PROTE chamber is that the FAA mandates users hold a current medical or BasicMed certification, which shuts out non-pilot passengers and LSA and glider pilots who don't have to fly with a medical. One solution may be to offer PROTE at 20,000 feet MSL for passengers and pilots of non-pressurized aircraft to better emulate the subtle onset of hypoxia over a longer immersion time.

Last, I lobbied the FAA department responsible for this safety area and was met with a tin ear and total insensitivity to the points I explained here. Perhaps *Aviation Consumer* can address this in a future article and make some headway for the safety of our industry.

Jim Herd
via email

We'll indeed look at the FAA's PROTE program in a future issue.

BECKER AVIONICS SERVICE PROBLEM

I think that there is a richer selection of radios than was presented in the navcomm roundup article in the August 2017 issue of *Aviation Consumer*. Perhaps if the intention was to cover navcomm radios only, then the selection would be somewhat limited. But the article did cover some commonly options.

I'd like to comment on Becker Avionics. I happen to own a pair of Becker 3201 comm transceivers in my Extra. These are ancient radios dating back to the late 1980s and my two transceivers function well even after all these years.

While I am happy with their performance, a few years back I had to service both of them. Specifically, the NiCd batteries that preserve the frequency presets were dying, which was not at all unexpected. What I did not anticipate was the level of difficulty I encountered obtaining proper replacement batteries. My experience tells me that the older radios are not enthusiastically supported here in the U.S. I eventually found a place in Pennsylvania that could sell me the correct batteries. I could not get a response from Becker USA in Florida.

For me the lesson is that among other things, I'd check into the company's willingness or ability to service older equipment.

Farrell Woods
via email

In the article we covered all navcomm gear approved for installation in certified aircraft, but didn't hit some models intended for experimentals. For those, we suggest reading the May 2016 issue of sister publication Kitplanes magazine.

As for Becker, it's trying to improve the support of its older gear partly with an online service request form so you'll know ahead of time if parts are available or not. Contact www.beckerusa.com.

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AIRCRAFT FLIGHT EVALUATION

Cirrus Vision Jet: Near Perfect Execution

The SF50 single-engine jet is everything Cirrus said it would be. It flies higher and faster than an SR22, but familiar ergos and handling should ease transitions.

by Larry Anglisano

For a moment, let's forget that the Cirrus SF50 Vision Jet is arguably the most technically advanced personal light aircraft we've ever flown. Or that Cirrus likely will achieve its goal of making it a safe step-up jet for qualified SR22 piston pilots. Moreover, its cabin and cockpit dwelling is perhaps the most satisfying we've experienced. But in our view, the most impressive thing about the Part 23-certified SF50 is that it even exists to talk about.

You see, the Vision Jet survives—thrives, perhaps—in a class of its own because its would-be competing single-engine jets, including Diamond's D-jet and the PiperJet (there are others), fell victim to the market's downturn in the early 2000s before getting into paying customers' hands. And although Cirrus' jet project initially stalled and almost melted before Chinese capital provided a needed refresh to the production and certification budget, we think the back-burnering of the project (and instead refining the SR22 line) is partly the reason why both models are so well executed today.

For this report, we spent a couple of days touring the Cirrus factory and the Vision Jet assembly line in Duluth, Minnesota, before flying the SF50 on a multi-leg trip to the Northeast. To see if the airplane really could make an easy step-up jet for existing SR22 pilots, we piloted a new SR22T for the trip out to make some comparisons in ergonomics, loading and handling.

LOWEST, SLOWEST, CHEAPEST

That kind of marketing language likely won't work in the twin-jet market, but when Cirrus said early on that The-Jet (that's what it was called at the time) would be the lowest, slowest and cheapest jet, it was talking directly to current SR22 owners—many who might have been trying to master the speedy high-performance piston. Today, you won't hear slow and low coming from the mouths of Vision Jet salespeople.

Instead, the reassuring takeaway from the sales demo is that the SF50—with a starting price of $1.96 million—flies a bit like a turbocharged SR22 (but higher and three times as fast) while carrying more in a cavernous pressurized cabin. Oh, and it also has the familiar CAPS whole-airplane parachute.

With typical speeds of around 300

Two million dollars buys a lot of ramp appeal. We parked N52CV on the ramp in Pontiac, Michigan, for a photo shoot where the aircraft was a superstar. You won't come or go unnoticed with it.

CHECKLIST

- ⊕ Fit, finish and cabin comfort is perhaps the best we've seen.
- ⊕ The SF50 offers a taste of the jet world at a cost that isn't absurdly expensive.
- ~ But at around $600 per hour, operating costs are roughly three times that of an SR22T.

knots true in standard conditions at a maximum altitude of 28,000 feet, the Vision Jet isn't exactly slow and doesn't really fly low, compared to the SR22. But you almost always want more.

On an eastbound leg cruising at the ragged tops of dissipating thunderstorms we didn't want to fool with (our demo had the optional Garmin GWX70 weather radar), a climb into the low 30s seemed like a good idea, but the SF50—which has the Cirrus-inspired Garmin G3000 avionics suite—isn't RVSM certified. That's a real money saver. Still, when asked if the airframe could handle it—like was it put through the wringer at higher altitudes—we were told most of the envelope testing was conducted at 28,000 feet and lower.

The SF50 is powered by a Williams International FJ33-5A turbofan that produces 1846 pounds of thrust. The -5A engine was certified in June 2016 (the original FJ33 was certified in 2004) and Williams designed the engine series for light jets in the 5000- to 9000-pound GTWO class.

The engine, which has dual-channel FADEC (full authority digital engine control), sits atop of the airframe just aft of the passenger cabin and has a dry weight of 308 pounds and a 4000-hour TBO.

CONSTRUCTION, FLIGHT CONTROL SYSTEMS

As one would expect for a Cirrus, the fuselage structure is primarily carbon fiber. The forward part up to the aft cabin bulkhead station is fabricated separately and assembled in a fixture, as is the tailcone. The carbon fiber structure below the engine is covered by a titanium firewall.

The empennage consists of two large carbon fiber surfaces in a V-tail configuration, along with two ventral fins that have attach points for the aircraft's yaw stability augmentation system (Yaw SAS) flight surfaces. More on that in a minute.

The ruddervators are the primary control surfaces for both pitch and yaw and are made of aluminum, and each has a large trailing edge pitch trim tab. Unlike the SR models, the SF50 has a manual pitch trim wheel in the center console.

The high aspect ratio carbon fiber wing structure houses the fuel bays (one in each wing) between the two spars. Each tank holds 148 usable gallons of Jet-A. The ailerons and wing flaps are aluminum and all of the control system components including the aileron push rods and flap torque tubes are routed along the rear side of the aft spar. Carbon fiber wingtips with LED lights attach to the upper and lower wing skins.

The Vision Jet has Garmin's G3000 glass avionics suite and includes three touch controllers configured in landscape, top. The center pedestal (middle) has stone-simple controls, including thrust lever, pitch trim wheel, flap switch and a simple fuel control. With its dual-channel FADEC, starting the Williams fanjet couldn't get easier, bottom.

Aside from trim tabs and balance tabs, Cirrus made good use of a variety of passive aerodynamic devices for improved low- and high-speed handling, including a wing-aileron fence that shields the aileron from wing-generated cross flow at higher angles of attack. The resulting aileron control response is good, if not light. The aircraft is also equipped with two wingroot vortex generators (one on each side) and two wing leading-edge stall strips. The aircraft also has Gurney tabs, which are long, thin metal strips attached to the trailing edge of each aileron, plus short trailing edge T strips.

The yaw stability augmentation system is controlled by an autopilot servo motor. The control surface, which is hinged to the ventral fin, rotates asymmetrically to actively

At 1846 pounds of thrust, the twin-spool Williams FJ33-5A fanjet, top, brings the right combination of power and efficiency to the SF50, which has a 6000-pound maximum takeoff weight. The V-tail, middle, is a complex system with a variety of passive and active systems that dial in handling and ride comfort. The jet has an electro-hydraulic retractable trailing link landing gear and Beringer wheels and brakes, bottom, for the best stopping power we've seen on an airplane without anti-skids.

augment lateral and directional stability. The system shuts off when the autopilot yaw damper automatically engages above 200 feet. Sitting in the rear cabin, we tried hard to sense the tail-wagging tendencies you'd expect from an airplane with a V-tail (yes, think V-tail Bonanza), but it just wasn't there. On the other hand, it was obvious that all those servos were working hard.

The SF50 uses control cables, pulleys, bell cranks, push rods and outboard sidesticks (with four-way hat trim switches) that have similar ergonomics as the side-mounted half yokes used in the SR models. As we do for the SR, we wish the Vision Jet had center control sticks, accepting that they would spoil the unrestricted space between the seats and the instrument panel.

There are several centering springs that help with roll, pitch and yaw stability and you feel them when hand flying. Like the SR22/20, if you don't properly trim, especially at slow speeds, you will lose the battle to fairly heavy control pressures. The SF50 has roll trim, via a dedicated servo motor, and we found it easy to keep the jet in trim.

CABIN, LOADING

The SF50 has a clamshell airstair door that we think is perfectly positioned just aft of the crew seats on the pilot's side of the cabin. Unlike other jets and some turboprops where you have to contort the body to get in from the center aisle, simply slide the pilot seat back and slide into the flight deck. Or, slide the seat forward so passengers can directly enter the rear cabin, which is 48.8 inches high and 61 inches wide. The 23.5-cubic-foot baggage compartment is located on the left side of the fuselage aft of the wing and accommodates 300 pounds. There's the Cargo X-Tend option for 40 pounds more, plus more space.

The rear cabin, with its modular seating, can seat up to five passengers, plus a pilot and a right seater, plus there's an option for a potty seat. The SF50 we flew had two seats behind the cockpit and three seats in the far aft cabin. Any combination of the seats can be removed by the pilot without worrying about revising the weight and balance data. A utility within the G3000 enables you to graphically change the cabin configuration based on the way you rejiggered the seating, then computes an onscreen weight and balance report based on loading.

The total cabin length is just shy of 12 feet and has remarkable amounts of legroom, headroom and large windows for a panoramic view outside. To give you an idea how spacious it is, a staffer emptied a large suitcase filled with a bunch of video gear onto the cabin floor around him, spread it out, organized it and repacked the suitcase while leaning over in his seat—and still had room left over. Got long legs? From the middle row, stretch them out as far they'll extend and we guarantee you won't be cramped.

The cabin fit, finish and creature comforts follow the lead of the current Generation 6 SR airplanes—which is superb. There are plenty of USB ports for charging devices, well-placed cup holders, an effective climate control system (with front and rear cabin controls) and good LED cabin lighting.

Passengers will want to wear noise-cancelling headsets, however. The whine from the Williams engine is dominant, partly because of its piggy-backed placement on top of the cabin.

As for loading, the useful load is 2499 pounds and the cabin payload with fuel (296 gallons usable) is advertised at 498 pounds. Cirrus believes its customers will travel in the Vision Jet much like they do in

CAPS IN THE JET: WILL PILOTS PULL?

Let's see, the Vision Jet has a conditioned bleed air pressurization system that's so automated it sets itself based on flight plan field elevation, it has an autopilot that won't let you fly too slow, too fast or out of control and a turbofan engine that's the ultimate reward of promised reliability after all those years flying temperamental pistons. Why in the world would the pilot pull the SF50's CAPS parachute? We're not so sure there will be many pulls, actually.

In the SR20/22, Cirrus has long taken a don't-wait-just-pull approach to CAPS deployment. But when you look at how the SF50 will be flown and who will be flying it, the guidance is different.

In the jet—which has a far better glide ratio than the piston—you're flying higher and might be able to reach more airfields if the engine fails. The flight manuals remind the pilot that a CAPS deployment will likely trash the airplane and to "consider when and how you would use the system." If you (or a passenger) must pull, automation does some of the work.

In the Vision Jet, the CAPS is packed in the aircraft's center nosebay and is harnessed to the wing root and the forward pressure bulkhead. If the aircraft is outside of the CAPS deployment speed envelope, the autopilot's throttle servo slows to the 135-knot activation speed. Cirrus tested the CAPS from a straight-and-level and nose-down attitude, but deployment from other attitudes is unknown.

Since Vision Jet pilots will be trained to ATP standards, we wonder if they'll be better prepared in a pinch to put the airplane back on pavement than a less experienced piston pilot would. But in the case of a midair collision or even pilot incapacitation that might have the passenger's hand on the red handle, the CAPS is still a major selling point just as it is in the SR models.

the SR22 and that's with one or two people on board. According to Vision Jet program manager Matt Bergwall, the airplane's sweet spot is regional travel in the 400-NM range, which is how many customers will fly the jet.

"Think 800 pounds and 800 NM, which was really one of the design parameters of the SF50. And, simply go slower if you want to go farther," Bergwall said. That's a good point. Throttled back, the airplane is just as happy cruising at 260 knots as it is at 300 knots. Lightly loaded, the jet can fly 1200 NM at a 240-knot economy cruise. As a general rule on an IFR day, Bergwall is comfortable landing with 80 gallons of fuel remaining.

Load the airplane with five adults and roughly 100 pounds of bags and the range is around 600 NM. For the first leg of our eastbound trip from Duluth to Connecticut on a wind-swept low IFR day, there were three adults and 100 pounds of bags on board. According to the flight planning data, we could have flown 900 NM at 300 knots if we didn't want to stop in Michigan to change pilots.

ICE AND SPEED PROTECTION

Unlike the SR (which uses TKS fluid), the SF50 uses mostly conventional methods for ice protection. The wing and stabilizer leading edges have pneumatic deice boots, the engine inlet is protected by engine bleed air and integral electric heaters protect the pitot probes and AoA (angle of attack) vane. The windshield and radome is protected by TKS fluid and a reservoir holds three gallons of it.

We got to use the boots (and the effective LED ice light on the left wing) during a descent through clouds from 28,000 feet at night. The switches for the ice protection are in the bolster panel just as they are on the SR22 and operation is easy. The wing and stabilizer pneumatic boots have three operating modes. When on, the controller automatically and continuously cycles the three deicer zones (stabilizer, lower wing and upper wing) for six seconds each, every 60 seconds. In other words, the surfaces inflate for six seconds then deflate and then the system dwells for 42 seconds. When in dwell mode (and when off), vacuum is applied to hold down the boots. There is also a single-cycle mode where the system cycles for 24 seconds and then returns to a dwell state. System status is displayed on the MFD's ice protection system synoptic page. Takeoff is prohibited with any frost, ice, snow or slush adhering to the wings, stabilizers or control surfaces, of course.

We've covered Garmin's integrated GFC700 autopilot (and the G3000) in other articles so we won't dive deep here. We will say that the G3000 (the SF50 has a PFD and an MFD) is a world ahead of the G1000, in our view, and it's nicely purposed for—and integral to—flying the Vision Jet. The airplane isn't flying around a bunch of avionics, as is the case with the G1000 in some airplanes.

Like in some other high-end airplanes, the GFC700 in the Vision Jet has overspeed, underspeed and envelope protection. The aircraft also has a left (pilot's) stick shaker for stall cues and a stick pusher in case of an imminent stall. Overspeed protection prevents the aircraft from exceeding 250 KIAS (or .53 Mach) by automatically pitching up to bleed off speed. A MAXSPD annunciator appears in a box above the airspeed tape on the PFD. There is also non-altitude and altitude-critical underspeed protection where the autopilot pitches the nose down and throws a MINSPD

The SF50's cabin is as spacious as it looks in the top photo. The large windows make it appear even larger. The view out the cockpit is equally pleasing, middle. The SF50 has real control sticks, bottom, but their placement mimics the half yokes used in the SR models.

warning on the PFD. The cues are tough to miss.

Speaking of warnings, we encountered an automatic pitch trim failure on one leg of our trip, in addition to a noticeable pitch porpoising during a high-altitude descent during another leg—unusual for Garmin's generally reliable GFC700 autopilot.

If there is a loss of cabin pressure (when the pressure altitude is sensed to be above 14,900 feet), the EDM (emergency descent mode) descends the aircraft to 14,000 feet at a speed reference that's 10 knots below the current structural speed limit and the autopilot holds it there. During the descent the EDM uses a throttle servo to reduce engine thrust to idle. Once at a safe altitude, the EDM will bring the throttle back to N1, or 83 percent. Is this an autothrottle system, you might ask? Sort of. The servo throttle works during CAPS deployment as described in the sidebar on page 7.

FLYING IT

The Garmin G3000 has an integrated checklist, which couldn't be easier to run through. Easier yet is starting the Williams engine, which has dual igniters that are software-controlled to alternate with each successive ground start. Turn the engine knob clockwise to Run, which enables the electric fuel pump, and push the Engine button once to begin the start sequence. The FADEC system commands the ignition on and schedules the fuel flow for starting once sufficient N2 speed has been reached. The igniters automatically turn off when the FADEC detects a successful lightoff.

The FADEC automatically aborts a ground start if the ITT rises too quickly or if the engine fails to light and accelerate within preset time limits. If the system detects an engine flameout in flight, an auto-relight is initiated using both igniters. There is also an engine fire suppression system, which uses dual high-rate Halon 1301 fire bottles that are discharged into the engine nacelle. The controls are in the overhead control panel, which also houses crew oxygen masks, an ELT switch and the CAPS deployment handle.

The SF50 has a two-generator, two-battery 28-volt electrical system with a main, essential and emergency bus. Aside from the similar cockpit styling, SR pilots should immediately feel at home in the Vision Jet's cockpit because the battery and generator switches are in a familiar bolster panel on the pilot's subpanel. This row of rocker switches has been used in the SR since day one.

The checklist says to hold the brakes when the engine is spooled but on a flat ramp the airplane is heavy enough not to roll forward at ground idle. We held them anyway. Out of the chocks, the SF50 with its 39-foot wingspan taxies like an SR. For steering, the nosewheel is full castering—rare in a jet. The nosegear strut (a conventional air/oil oleo shock/strut extending from a trunnion) has self-centering cams to lock the wheel straight when the strut is extended and the gear is retracted.

With the thrust lever in the takeoff position and flaps at 50 percent, the 90-knot rotation speed comes quickly, but not blistering fast. Typical ground roll is around 2000 feet. Unlike an SR22 that will fly itself off the runway if you hold the right amount of back pressure, you deliberately rotate the Vision Jet. With the flight director in takeoff mode commanding 5 degrees of pitch up, the jet has plenty of climb authority once it's off the runway. Retract the

continued on page 10

On the factory floor

THE UNENDING QUEST FOR EFFICIENCY

When I asked Cirrus manufacturing VP, Rick Hollander, if adding the SF50 Vision Jet to the assembly line was like tossing a rock in a quiet pond, he had a ready answer: "More like a boulder," he said.

It's easy to see why. Although it has expanded with off-site annexes, the basic footprint of the Cirrus factory hasn't changed appreciably since the first airplanes were delivered in 1999. But it has undergone substantial reorganizations and yet another was underway when we visited Duluth in August 2017.

At peak production a decade ago, Cirrus was building more than 700 aircraft a year, but more recently, that number has been less than half that. For 2017, total SR-series production was expected to be the highest since the 2008 downturn, at about 350. Jet production is ramping up to about one a week and will be twice that rate by the end of 2018.

There's obviously a method to all of this, but it's not a process that benefits from stasis. Making even minor changes to a production line, says Hollander, causes instability in workflow that ripples through the entire line and slows overall output.

Cirrus does its primary composite work in Grand Forks, North Dakota, 267 miles west of Duluth. Cirrus split the factory for the simple reason that Grand Forks offered an attractive deal, leasing a building that the city actually owns.

Once a week, a truck carrying fuselage and wing halves and the entire carbon fiber fuselage of the Vision Jet arrives at Duluth from Grand Forks. The parts are prepped and gritted, then essentially glued together using heat-setting adhesives cooked in low-temperature ovens.

Although there's evidence of automation here and there, assembly of both the SRs and the jet is handwork intensive. We saw lots of workers using power sanders to clean up the subassemblies before moving them to what Cirrus calls the mid-assembly line. That's where the aircraft is winged, its complex center console is installed, the airframe is wired, engines are hung and windows are installed. At the current production rate, the SR airframes move to the next station every 5 ½ hours.

At the end of the mid-assembly process, the aircraft are towed down the street to a new, state-of-the-art paint facility Cirrus just opened in early 2017. Paint takes a couple of days for the basic work, but a week of additional detailing before the airplane is ready for delivery. Between initial paint and final detail work, the airframe returns to the main factory for final assembly work.

Every two years, Cirrus reviews its production flow looking for places to shave hours off the build time. That includes videoing some of the processes and reviewing the results with floor workers to refine the flow and find efficiencies. They've been at it long enough that the gains are coming in minutes, although on the newly formed jet line, hours are up for grabs.

Aircraft factories—save for Boeing and Airbus—generally lack the automation that's commonplace in automotive plants. But that's not to say Cirrus makes no use of it. In a segregated cell at the end of one building we saw a rail-mounted CNC drilling machine boring holes in wing and fuselage assemblies. "A lot of people put in technology because it's sexy. But if there's not a return, we're not gonna do it," Hollander said, telling a story we've heard before. "But what we're finding out as we incorporate the jet volume, we're reaching that threshold where maybe robotics do make sense. And maybe an electronic work order system makes more sense than the old paper system we've been doing for 20 years," he adds.

Ten or 20 years from now, will there be major efficiency gains in aircraft production? Hollander doesn't think so. The company considers it a victory if it can retain trained workers, hit its quality targets and keep costs flat.
—Paul Bertorelli

landing gear when there is a positive rate of climb and then clean up the flaps at 115 knots indicated. Takeoff thrust is limited to five minutes and the drill is to pull it back to the MCT (max continuous thrust) position within two minutes. Holding the 5-degree pitch attitude yielded 155 knots in the climb and roughly 2500 FPM, which made for a comfortable deck angle out the huge windshield.

With the yaw damper automatically coming on at 200 feet the ball stayed centered throughout the hand-flown step climb to 27,000 feet. Once at altitude, we engaged the autopilot and enjoyed the most impressive outside visibility we've seen, aside from gliders, maybe.

As sexy as the Vision Jet looks on the ground, it doesn't exactly have Formula One racer handling. It's heavy in the roll and pitch axes and hand flying it accurately takes concentration, but Cirrus teaches the importance of using all of that automation so we suspect many pilots will engage the autopilot early in the climb.

As for performance numbers, Cirrus doesn't tell white lies. As we've experienced flying every generation of the SR22 and SR20, the SF50 made book speeds. On a warm ISA+15 day at 27,000 feet (at 48-percent thrust power), we saw 284 KTAS on 58 GPH. We were chewing miles with a 310-knot groundspeed.

As jets go, the Vision is easy to slow down while going down even though it doesn't have speedbrakes. Some of that has to do with the 210-knot landing gear extension speed and the first notch of flaps that can be extended at 190 knots. With gear down and flaps at 50 percent, a thrust setting of 35 percent made it pretty easy to slow to and hold a 140-knot approach speed.

The aircraft flight manual recommends landing with full flaps in normal conditions, and 50 percent flaps in crosswinds higher than 15 knots or when there is ice on the airframe. Cirrus marketing folks remind potential buyers that the SF50 really has landing speeds similar to the SR22 and it does. Plus, the SR22 already has a jet-like landing attitude. If you've flown one you know you absolutely have to keep the nose down, and that sight picture—and similar speed—is what you'll want while landing the Vision Jet. Landing ground roll is around 1700 feet and there is no thrust reverser, but instead the Beringer wheels and braking system that do an impressive job of bringing the jet to a quick stop.

The clamshell airstair door is nicely positioned for crew and passenger ingress, top photo. That's a new Vision Jet in the paint and finishing center shown below. It's a lengthy process in which Cirrus has invested big, but we think the paint quality on the SF50 and SR22/20 is Cirrus' best effort.

WANT ONE?

Get in line. As we go to press, Cirrus has orders for roughly 600 Vision Jets and is delivering one per week. The current price of a typically equipped SF50 is around $2.1 million. Who will buy them? In our estimation, it will be a diverse group—plenty of owners stepping up from the SR22—with some stepping up from single-engine turboprops and some stepping down from twin turbojets.

No matter what you come out of, you'll need a type rating to fly the SF50 and Cirrus has thought a lot about how it trains pilots new to the airplane. We're always reluctant to put time predictions on initial training, but Cirrus says the type rating training might be completed in 10 days and many will fly with mentors for a while. We spent some time with Rob Haig, director of flight training and operations at Cirrus, who told us the training process begins long before a new owner takes delivery of an SF50.

"We set the custom training program specifically for owner pilots, meaning the person who purchases the SF50 will be the one flying it. That's not typical of a turbojet airplane," Haig said. He made it clear that instrument competency is a core skill that's evaluated during the initial skill assessment and training consultation. Cirrus will eventually have a Level D simulator at its Vision Center in Knoxville, Tennessee, but the training is currently being done in Duluth in an actual SF50. It also has a Level D-quality fixed device that has an unusual hypoxia and ATC simulation.

We wonder what will be next for the Vision Jet, an airplane that does what Cirrus promised it would. A big part of that is a realistic step into the jet world for loyal SR22 owners sold on the Cirrus brand. For those who can afford the $2 million entry fee, we think they'll get one of the best-value high-end personal aircraft we've evaluated.

YouTube Watch a video report on the SF50 at http://tinyurl.com/yb79p4da

The $60K Slide: Post Gear-Up Strategies

Whether it's your fault or not, your insurer will cover it. But when the check is cut, you'll do better if you stay involved in the repair process.

by Paul Bertorelli

CHECKLIST

- If you suffer a gear-up, don't worry. It happens. Insurers will cover it.
- Injuries, death and even fire are relatively rare if the slide stays on the runway.
- Get the repair done right to minimize the hit on aircraft value.

Now that cockpit GoPro cameras are as common as iPads, it's only a matter of time before someone posts the ultimate deer-in-headlights moment: the shock and terror of a pilot just commencing an inadvertent gear-up landing, otherwise known as the $60K slide.

It might be just as interesting if the camera kept running through the aftermath—the runway recovery, the call to the insurance agent and, ultimately, what to do if this happens to you.

Despite the worn cliché of those who have and those who will, the risk of a gear-up landing is relatively low, although there are indications that the incidence of gear-ups is increasing. Fortunately, a gear-up landing—whether inadvertent or unavoidable—is hardly a life-threatening event. Injuries are all but unheard of and if the airplane is properly insured, it's repairable. But not always. Older retracs with hard-to-find props and parts may be an economic loss after a gear-up. And parts are definitely getting harder to find.

In this report, we'll sort through the accident record on gear-up landings and offer advice on what to do if you have one. Hint: In your own best interest, involve yourself intimately in the repairs. Don't drop it off at the shop and let your insurer sweat the details, unless the shop has a good relationship with your insurer.

Compared to Cessna 210s, V35 Bonanza gear-up landings are less common. A replacement prop and an engine teardown and inspection are on the repair list.

ACCIDENT OR NOT?

We swept 10 years worth of NTSB accident records on gear-up landings looking for useful clues in the data. Why do they occur? How do they occur? Can you avoid them? How many are there?

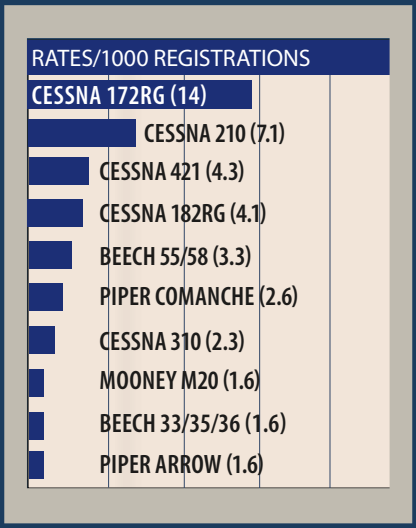
That last question is the most fraught, for everyone we spoke to for this report agrees that not all gear-up landings are reported to either the NTSB or even insurers. The reason is obvious. Pilots are worried about getting tangled up in an FAA enforcement action and if evidence can be quickly recovered from the runway and tucked away in the dark corner of a maintenance hangar, who's to know?

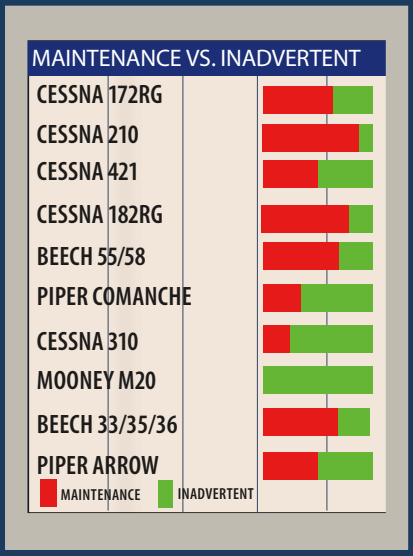
The larger reason may be regulatory. NTSB 830, which defines reportable accidents and incidents, has specific language that precludes the requirement to report typical gear-up landing damage because it doesn't meet the threshold of "substantial damage."

If, on the other hand, a passenger or crew member was injured in the gear-up, rare as that is, or the airplane slides off the runway and takes out the glideslope shack, an NTSB filing is required. In that context, we're not sure why so many gear-up landings actually *are* reported. But we're glad they are, because without even this minimal data, we would have no inkling of why these things happen.

We looked at NTSB-listed gear-up landings that occurred between 2005 and 2015. We found a total of 156. That's an average of 15 a year or a little over one a month. We suspect the actual occurrence is several times higher than that for the aforementioned reasons. You probably know that airlines aren't immune from

GEAR-UP RAW DATA





To gain a sense of how gear-up incidents compare among models, we sorted the NTSB data to calculate gear-ups per 1000 aircraft registered. Two caveats: As we noted in the main article, only a fraction of gear-ups make it into NTSB records. Although we can't confirm it, for this comparison, we're assuming all models are equally reported or underreported to the NTSB.

Second, accurate registration by model is difficult to come by. The FAA's Wichita Aircraft Certification Office helped us find what we believe is the best registration data available. While the Cessna 172RG is at the top of the list, that's by dint of low registration numbers; only about 572 remain on the registry, compared to 3800 210s. We think the data reasonably show that Cessna singles are involved in more gear-ups than other models.

The second graph shows the relationship between maintenance-related gear-ups and gear collapses and inadvertent gear-ups. Again, it indicates the high incidence of problems with Cessna gear systems.

gear-up landings, but we mostly excluded these from the dataset.

Bizjets have their share, too, commonly related to worn parts or poor maintenance. The two-pilot jet set is relatively immune from the inadvertent, antenna-smearing, belly-skin-rashing ride down the pavement sans wheels. Training helps, we're sure.

Ah, were it so with the weekend pilot flying the kid to college or practicing approaches, especially owners of Cessna 210s. Our review of the data shows that 44 percent of gear-up landings come as a complete surprise to the pilot, while 35 percent are what we might term unavoidable. In other words, the pilot was aware of some kind of gear problem and landed with the gear stowed in the wells or with one or more legs fully or partially extended.

The remaining 20 percent of gear-up incidents aren't, technically, gear-ups if you define the occurrence as landing with no wheels at all or just partial extension. This category consists of pilots landing with what they thought was normal gear extension, only to have the wheels collapse. These are due to hard landings, side-loading in crosswinds, downlock failures, various kinds of poor maintenance and, according to some of the reports, no particular reason at all.

I JUST FORGOT

If there's a common theme in gear-up landings, you'd have to be as dense as a mud fence to miss it: cockpit distraction. Time after time, pilots who've done the slide tell the FAA or investigators that something distracted them from their normal routine and lowering the wheels just got overlooked. More than one pilot said the gear-up warning horn was blaring away but went unnoticed until the airplane ground to a halt.

The hit parade of distractions? You name it, it's on the list: Tower changed the runway; looking for traffic; worrying about a crosswind; impromptu CTAF debates; a go around; confused by a checklist; an odd smell in the cockpit. If the overwhelming majority of retractable pilots didn't land with the wheels properly locked, you could be forgiven for thinking pilots have the attention span of gnats.

But even those who forget the wheels have probability on their side. Injuries and fire aren't unheard of, but are so rare as to barely merit mention. The one fatal we found involved a Mooney pilot who realized he had neglected the wheels when the prop started chewing up the runway. He attempted a go around and flew into a tree.

We found three incidences of fire, one caused when the airplane slid off the runway and had the wing tanks sliced open by runway lights. One airplane burned after the slide was contained on the runway, evidently because of a minor fuel leak.

Although we couldn't find meaningful data to support it, sliding on concrete or asphalt appears to cause less damage than risking a landing in grass, which can hide obstacles and cause parts of the aircraft to dig in, potentially flipping it or causing more damage.

THE GEAR BROKE

Landing gear systems tend to be reliable, but the data shows they're far from foolproof. That's especially true if you're flying a Cessna 172RG or 210, the twin poster children for gear that won't play when the switch is moved to down. More on that in a moment.

As with gear-ups in general, there's a discernible pattern in gear systems that malfunction. Mooneys and Bonanzas seem to suffer the fewest problems, Cessna singles the most and Cessna twins after that. The accident record is replete with stories of gear that wouldn't come down or that collapsed on the runway, only to work perfectly when swung for a post-incident check.

Airplanes that use electric/hydraulic systems seem to be the most susceptible to gear extension failures. That would be Cessna and Piper and

larger twins. For their singles, Beech and Mooney have favored electric motors driving transmissions that lower the gear with rods and bell cranks. All gear systems are susceptible to misrigging, but this appears less often as an issue in Beech and Mooney singles.

And that gets us to the Cessna 210. We found 27 gear-up incidents with the 210, or 17 percent of the total. The 210 is significantly overrepresented in the data. Of the 27, only one was an inadvertent wheels-up landing. Fully 96 percent of the 210 gear-ups we found were due to some kind of mechanical failure in the system. And there's plenty to fail.

We found examples of hoses that leaked, fittings that parted, doors that hung up, motors that burned up, linkages and downlocks that failed, modifications done improperly—it's enough to start you shopping for a 206.

In the past, we've noted that the Cessna 210 gear is well designed, but requires careful maintenance. As the fleet ages and parts get more expensive and difficult to get, our view is that it's generous to call the Cessna gear system well conceived. It clearly just isn't as reliable as the Beech and Mooney designs. Even owners who are diligent about maintenance have gotten bamboozled by their mechanics.

In one case, a mechanic failed to install a replacement hydraulic line and in another, a gear door modification was done improperly. Owners do their part to keep the 210's gear-up stats at the top of the leader board. One pilot took off with a near-dead battery and was shocked to discover the gear retracted only enough to knock it off the downlocks. His reward was a landing with partially extended gear which, in a 210, isn't especially pretty.

Retractable versions of the Skyhawk and Skylane suffer similar problems. Our chart on page 12 reveals that the 172RG Cutlass actually has twice the gear-up rate as the 210. However, its low population distorts the data somewhat.

Piper systems, which use an electrically driven hydraulic power pack, don't appear to have as many hydraulic issues as the Cessna systems do. They do suffer from broken links and failed downlocks.

Thanks to the ubiquitous newscopter with gyro-stabilized cameras, your gear-up could make the local news, right. (Credit KOMO news.) Swinging the gear regularly won't forestall a gear-up, but not doing it at all will almost guarantee one, lower photo.

THE AFTERMATH

Baked into the actuarials by which insurance companies make profits despite boneheaded pilots is the realization that people land gear-up. Don't worry, they're used to it and nary an insurer exists that doesn't know how to process a gear-up claim. That said, if you have a gear-up, there's a right way to handle it and a less right way.

It will be a large claim. David Thibodeaux, who owns Flying T in North Texas, specializes in gear-up repairs and reports invoices between $60,000 and $90,000 for a typical single. Twins can be well above that and costs are escalating because parts are ever more difficult to find.

Our in-house insurance expert, Jon Doolittle, of Sutton James, says that underwriters are split on whether they're seeing more gear-up landings. But there's discernible worry that the recent passage of the BasicMed rule will have the positive effect of keeping older pilots flying longer but the negative effect of more gear-up landings due to distraction and memory issues in older airmen. "It doesn't take someone almost running into an airliner to cause a gear-up," Doolittle observes. "Now it could be a Mylar balloon."

Doolittle says that what data exists

If the wheels fold up, there's always a chance they won't come down when needed, as the crew of this military Citation discovered in 2009. (U.S. Air Force photo.)

ABOUT THAT ENGINE...

Depending on the make and model, tending to the engine after a gear-up may be the most expensive part of the job. If it's a twin, make it times two.

Make no mistake, after a gear-up landing in which the prop has been damaged, even a little, the engine will have to be torn down and inspected and insurers aren't going to skip this step.

But they're also not going to buy you an overhaul. Following the betterment doctrine, the insurer will pay for the prop and the labor to T&I the engine. It will also pay for damage done to the engine as a consequence of the sudden stoppage. That could be a cracked case or crank, broken gears or other parts or nothing at all if the inspection yields no damage.

Shops we checked with told us that as much as half of their work is prop strike inspection and the labor to do that can total between half and two thirds of overhaul cost, presenting the owner with a dilemma.

Since the engine is torn down, doesn't it make sense to go ahead and overhaul it? It might, especially if the engine is past mid-time. Add whatever parts are necessary—cylinders, cams, lifters and so on—and the labor to put it all back together is on the insurance company's dime. But they aren't the hook for new or even service-limits overhaul parts. They may also insist on some proration on parts that are serviceable with repairs.

How often is damage found? "I would say rarely. We see it more on Continentals than Lycomings," says Penn Yan Aero's Bill Middlebrook. Still, crankshafts occasionally break at the flange.

Middlebook and other shops told us they're constantly in discussions with insurers over what has to be done and what will be paid for in the claim. Rare is the engine that's opened up with no evidence of problems in need of attention.

Owners go both ways on whether to overhaul or just settle for the T&I. Penn Yan sends two quotes, one for the parts the insurer will pay for and a second that the owner has to cover.

At Certified Engines in North Perry, Florida, they do the same. "But the keyword we hear is: betterment," says Certified's Allen Weiss. Insurers will sometimes dicker and get down into the weeds over the list of parts. For the most part, says Weiss, insurers pay what they're supposed to and everybody's happy.

suggests that pilots who suffer gear-up landings tend to be high-timers and perhaps with high time in type, but currency is an issue as owners fly less. Our sweep of NTSB data was inconclusive on this point. Nonetheless, insurers cover gear-up landings, just don't expect the policy to make you entirely whole.

A basic principle in the insurance business is that policies are supposed to cover reasonable, documented losses but not leave the policy holder better off than he was when the claim was filed. The so-called betterment doctrine makes things sticky when damage not caused by the gear-up has to be repaired.

For example, gear-up landings almost always trash the prop, requiring an engine teardown and inspection. If the inspection reveals a required AD against a part like a cam, crankshaft or magneto that wasn't damaged by the gear-up, the insurer is likely to balk at paying for it, even though it will pay for the basic inspection. If the cam is trashed by spalling or corrosion, same deal. You'll have to replace it, but it won't be covered on the claim.

The same is true of airframe parts that might be damaged or worn and in need of replacement, but weren't damaged by the gear-up. Pretzeled props are routinely covered in gear-up landing claims, but increasingly, they are being prorated, according to Doolittle's findings. That means if the prop was halfway to TBO, the lower value may be subtracted from the insurance claim.

Doolittle says that owners should expect to pay something after a gear-up claim. But to minimize that something, owners should remember that it's not the insurer's job to find a shop, negotiate repair prices and scope and oversee the work. That's on the aircraft owner.

Often, the work is done where the gear-up happens, but it doesn't have to be. If the aircraft is not heavily damaged, it can be flown elsewhere for the repair, under a ferry permit.

This gives the owner the option of taking the airplane to a familiar shop that's closer to home or one that specializes in this type of repair. Flying T is one such shop and Thibodeaux told us he much prefers to deal with a known insurance company than an owner who wants to nickel and dime every aspect of the repair work.

Lacking a specialty shop, however, the insurer won't necessarily intercede in any of this unless the estimates are outside the company's reasonable expectations. They may ask for detailed estimates before the work is approved. And remember, everything is negotiable, both with the insurer and the shop doing the work. Doolittle says owners who remain involved in the repairs in detail and document why they think certain parts should be replaced when they otherwise might not be will get a fairer shake than those who just drop the airplane off and ask for a call when it's done.

"That's the difference between a good company and a very good company," Doolittle adds. "The very good ones are more likely to step up and make it right." Those very good companies might charge slightly higher premiums—or not—but the payoff will come when they don't peck the owner to death on insurance claim line items.

The aviation insurance industry is currently over-served and intensely competitive, a business environment that makes companies think twice about denying too many claims. Word gets around, especially among independent agents. Just don't assume companies will step up without being nudged in the right direction by a cooperative attitude, good owner legwork and ready documentation.

YouTube See a video report on gear-up landings at http://tinyurl.com/y6w44h79

Sub-$200 ADS-B: Scout Versus RXWX

The uAvionix Scout is tiny and completely plug-and-play, but a pre-built Stratux-based system like the RXWX offers far more capability for the same price.

By Jeff Van West

Yes, you can get datalink weather in the cockpit for less than $200, plus a tablet device of some kind to play it on.

With the ADS-B mandate creeping closer, we're seeing more aircraft owners pony up for the minimum compliance of ADS-B Out when transponder work is needed. That satisfies the FAA, but does nothing for receiving weather and traffic information in the cockpit. We flight tested two units that get it done for rock-bottom pricing.

JUST THE FACTS

There are a dozen or more portable ADS-B receiver options out there. Most are several hundred dollars, including the well-known Stratus 2S. This unit only plays its data on ForeFlight, but that's the app the majority of pilots use. With built-in GPS position, dual-band traffic, AHRS, pressure-altitude sensor (p-alt) and backup battery, the Stratus 2S sets the gold standard, matching or besting every other portable system in our previous evaluations. It's also $899. Stratus offers the 1S, which offers only the GPS, battery, weather and one traffic antenna. At $549, that's still not budget, in our view.

Enter the Scout, developed by uAvionix and sold exclusively for use with ForeFlight. It's a dual-band ADS-B receiver for weather and traffic, and nothing more. No battery, no GPS, no AHRS and (importantly as we'll see in a moment) no p-alt sensor. Scout is about the size of three sticks of Juicy Fruit gum, and comes with a suction cup and a long USB cable. Hang it up, plug it in, connect via Wi-Fi to your tablet and you're done. Price: $199.

The Scout (on the left in the photo to the left) is hardly larger than the cable needed to power it. The RXWX (on the right) needs more power, but could contain an internal battery in later versions.

The only other option for under $200 has been building your own ADS-B In using the open-source Stratux software, created by Chris Young. This system uses off-the-shelf hobbyist equipment to create something that, on paper, has all the features of a Stratus 2S. We built one and reviewed it the February 2016 *Aviation Consumer* and found it functional, but not equal to a production Stratus 2S in performance. However, it can send data to virtually every aviation app, including ForeFlight.

Young has continued to develop Stratux, and has allowed other companies to sell pre-assembled ones, including iFly, FlightBox and the new Merlin by Seattle Avionics. Young has also launched his own pre-built box with dual-band, high-gain antennas, GPS, AHRS and p-alt. It's called the RXWX. Price on Amazon: $179.

Ladies and gentlemen, we have a contender.

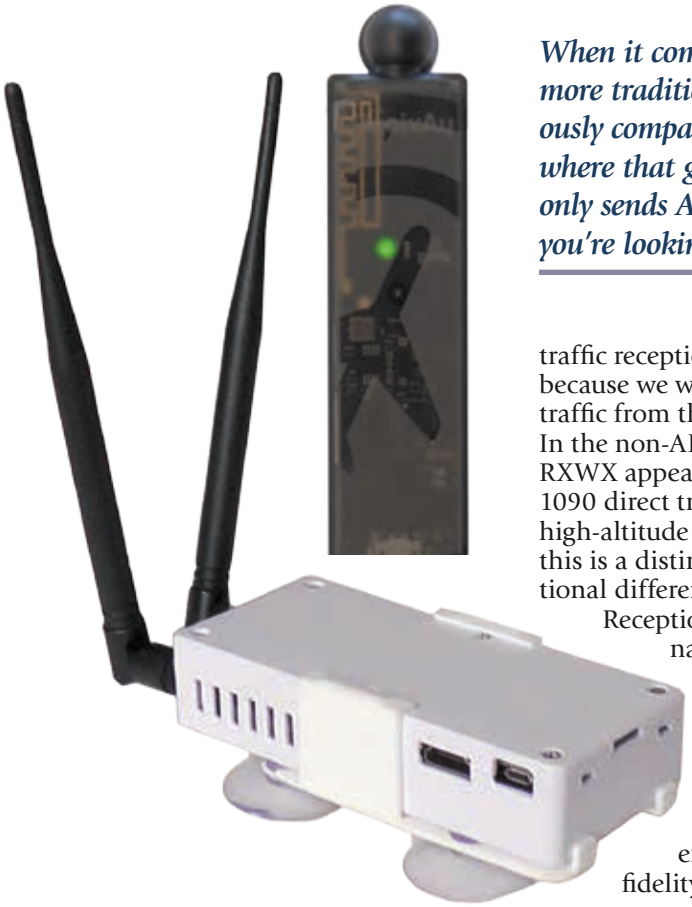
HEAD TO HEAD

We flew with the Scout and Young's prototype RXWX in northern New England where ADS-B tower coverage is marginal, and on a 1700-mile trip to watch a certain two-minute celestial event. That trip was in an airplane with both a Stratus 2S and a Garmin GTX 345 ADS-B transponder for comparison. Ranking the results depends on what matters most to you: performance, convenience or features.

Performance-wise, the RXWX bested the Scout, but not by much. We routinely saw the RXWX picking up one or two more ADS-B towers than the Scout. This ceases to matter

CHECKLIST

- ✚ At this price, there's no excuse for not flying with ADS-B traffic and weather.
- ✚ The uAvionix Scout is easier to manage in the cockpit thanks to a slim footprint.
- ⛔ But the Scout only works with ForeFlight, while the RXWX uses the open Stratux architecture.



When it comes to chassis design, we prefer the Scout (top) over the more traditional RXWX (white device in the middle) because it's seriously compact (think memory stick) and easier to hang virtually anywhere that gives it a clean view outside the aircraft. However, the Scout only sends ADS-B weather and traffic data. There's no GPS or AHRS if you're looking for an app display as shown at the bottom.

traffic reception between the units because we were receiving custom traffic from the ground stations. In the non-ADS-B Out aircraft, the RXWX appeared to pick up more 1090 direct traffic, but it was all high-altitude airliner traffic. We feel this is a distinction without a functional difference.

Reception is all about antennas, and uAvionix told us that's a place Scout is challenged, because of its small size. Stratux units are challenged there because they use tunable receivers that don't have the fidelity of dedicated ones. For comparison, the Stratus 2S routinely picked up one or two more towers than either Stratux or Scout, and the installed GTX 345 with its external antenna could read even more, and much sooner.

Scout wins hands-down for convenience. It dangles in a window like an air freshener. You must plug it in because it has no battery, but it draws so little power that it'll run all day on a cellphone backup battery with charge remaining. The same battery can't even power an RXWX. You'll want a 10,000 mAh USB battery, or have the RXWX plugged in, for reliable operation.

The next version of RXWX may have an internal battery backup for a couple hours operation, but that unit will retail for more than $200.

During our evaluations, we did quite a bit of app-switching and noticed the RXWX seemed slower in reconnecting to ForeFlight than Scout or Stratus after switching apps or waking the iPad from sleep mode. This delay was a minor inconvenience, and would be a non-issue if you left ForeFlight open throughout the flight.

Scout has automatic firmware updates through ForeFlight. Updating RXWX (or any Stratux-based system) is done via a webpage off your tablet or through an app that offers that feature, like the free version of Aerovie. Point to Scout if you're a ForeFlight user.

FEATURE SET DIFFERENCES

If you're not using the ForeFlight Mobile app, a Scout is of no use to you. In an earlier version of the product, it wasn't exactly supposed to be that way as we explain in the sidebar on page 17.

However, there are two good reasons even a ForeFlight user might want the RXWX even though it's bigger and more power-hungry. One is if your tablet doesn't have a reliable GPS source. RXWX offers WAAS-GPS that was rock solid in our tests.

The other is p-alt for traffic, particularly if you have ADS-B Out. RXWX (as well as Stratus 2S or installed ADS-B In like the Garmin GTX 345) uses your current pressure altitude as part of the equation to show relative traffic altitudes.

The Scout uses pure GPS altitude. The difference is rarely more than a couple hundred feet—but that makes all the difference when the alert delivered by the Scout says traffic is 200 feet above you and the RXWX shows it at your altitude.

Given how much traffic there was around the eclipse, we had opportunity to see this behavior more than once. This is worth serious consideration if the portable ADS-B In is your only traffic display.

RXWX, and all the Stratux-based systems, have a couple other things going for them. One is clearly the once three towers are in range, so the importance depends on where you fly and how high. In the ADS-B Out aircraft, there was zero difference in

WHAT HAPPENED WITH THE PINGBUDDY 2?

The buzz at Sun 'n Fun this past spring was the uAvionix pingBuddy 2, a dual-channel ADS-B In receiver that had essentially the identical chassis as the current Scout. Priced at $149.99, Seattle Avionics (maker of the FlyQ app) was one of the major companies pre-selling the device and expected to start fulfilling orders within a month. If you bought one, you know the orders never came to fruition. Seattle was ultimately tasked with refunding its customers—and eating the credit card fees and its pingBuddy 2 advertising investment. Other vendors were to sell the pingBuddy 2, too.

We asked Shane Woodson, the uAvionix sales director, just what happened with the pingBuddy 2. He told us the company pulled the device back into development, reiterating that the product was only offered initially for pre-order, never really made it to the market and was never shipped to customers due to various delays.

"We later collaborated with ForeFlight to help accelerate the product to market, for integration and for the user experience," Woodson said.

The real story here is that the pingBuddy 2's replacement—the Scout—is only supported on ForeFlight Mobile and iOS. As we said in the main text, it's useless if you want to use it with Seattle's FlyQ and WingX, to name two apps, or on an Android device. Frankly, we don't see this closed architecture benefiting the market. To be fair, Garmin has faced similar criticism for some of its products, including some ADS-B receivers. According to Seattle Avionics' Steve Podradchik, the market once benefited from industry standards and good interoperability between devices made by different vendors, but ADS-B has been the exception. Podradchik makes a solid point that ADS-B receivers rebroadcast (over Wi-Fi) traffic and weather data that's paid for by tax dollars.

"We've seen some vendors open its system architecture, but ForeFlight has consistently been on the vanguard of closed systems, presumably because it is worried about a sliding market share," he told us.

On the other hand, ForeFlight did open its app to Garmin when the company's later-gen Flight Stream wireless cockpit network hit the market. This enables ForeFlight Mobile users to display Garmin's ADS-B weather and traffic data, plus send flight plans bidirectionally between the panel and the tablet app. Competitors still, Garmin's Pilot app has gained sizable market traction. Plus, Garmin's recently introduced GDL50-series SXM/ADS-B receivers only work with Garmin Pilot app and some of the company's portable GPS systems and not with ForeFlight.

As we go to press, Seattle Avionics announced its own branded ADS-B receiver called the Merlin. Expected to sell for $250, it's based on the Stratux core, but for buyers who don't want to assemble their own, Seattle does and includes a battery, tests the unit and provides a users manual. Unlike the Scout, Seattle says the Merlin will have an open architecture for playing with a variety of third-party apps.

—Larry Anglisano

use in apps besides ForeFlight. Young is also developing other interfaces, including a community-sourced ground weather network for Canada. He's committed to keeping Stratux open-source and available for personal and commercial use.

AHRS INPUT FROM RXWX

Under the current Stratux build, RXWX and related systems can't send AHRS data to ForeFlight. This was specifically disabled by ForeFlight. Officially it was because they didn't want AHRS information from equipment they couldn't vouch for appearing in their app for liability reasons.

CONTACTS...

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www.uavionix.com

The policy also gives the Stratus 2S the sole ability to offer backup AHRS in the most popular app out there.

Young has a workaround in development for AHRS to ForeFlight and hopes the growing number of Stratux-based users will convince ForeFlight it's a net positive in gained safety rather than a liability negative. Only time will tell.

Some Stratux users have reported better results with the Stratux AHRS system compared to the one in the Stratus 2. This has not been our experience in multiple tests. In fact, we've found the Stratus 2S AHRS to be the most reliable, easiest to adjust iPad AHRS on the market. We've even seen it outperform the backup AHRS in the Garmin GTX 345 transponder.

That said, the AHRS performance from the RXWX was adequate for basic aircraft control using WingX Pro or Aerovie. Head-to-head the Stratus 2S was still a better performer in our tests in coordinated or uncoordinated flight. Extreme changes in attitude tested on the ground (because we didn't have an aerobatic aircraft handy) will confuse the units about equally.

The biggest factor in AHRS performance seems not to be the sending unit so much as the tablet displaying the AHRS information. It's demanding graphically, and small delays make huge differences. If this function matters to you our strong recommendation is to invest in the fastest, newest tablet you can, more than any specific AHRS source.

NO EXCUSES

At under $200 you can't ask for much less in price to put weather and traffic in your cockpit. And while consumer electronics prices keep dropping, there is a bottom end just to make it worth someone's time to sell. We may be there now. You can't go wrong with almost any receiver for weather and traffic, but before you scoop up a Scout for its simplicity and size, consider an RXWX or similar unit for more features at the same price.

Redbird GIFT: Flight Training Upgrade

By taking advantage of developments in artificial intelligence and flight sim visual displays, we think Redbird has found a better way to teach maneuvers.

by Rick Durden

The most basic stepping stones to be traversed by a student pilot going after a certificate involve figuring out where she or he wants the airplane to go and learning the monkey motion involved in causing it to go there. We've gotten all sophisticated over the years and refer to that sort of thing as flight maneuvering tasks. Nevertheless, the process of

TRAINING TOOLS

teaching student pilots the rudiments of shoving an aircraft through the sky—straight and level flight (at the same time?!), turns, climbs, descents, slow flight, stalls and takeoffs and landings—have not changed a great deal since the Wrights set up their flight school. An instructor describes the maneuver, demonstrates it and then has the student practice it repeatedly, with coaching and feedback, until the student demonstrates the ability to perform it within acceptable parameters.

The process takes expensive airplane time—as the Russian proverb says, "Repetition is the mother of learning." A student does steep turns until his internal gyros tumble as he strives to maintain the desired bank angle, altitude and airspeed while—assuming he has a good instructor—getting suggestions about such things as pitch attitude, where to look for reference points, how to quickly glance at the altimeter and airspeed indicator and use of trim that help him perform within tolerances.

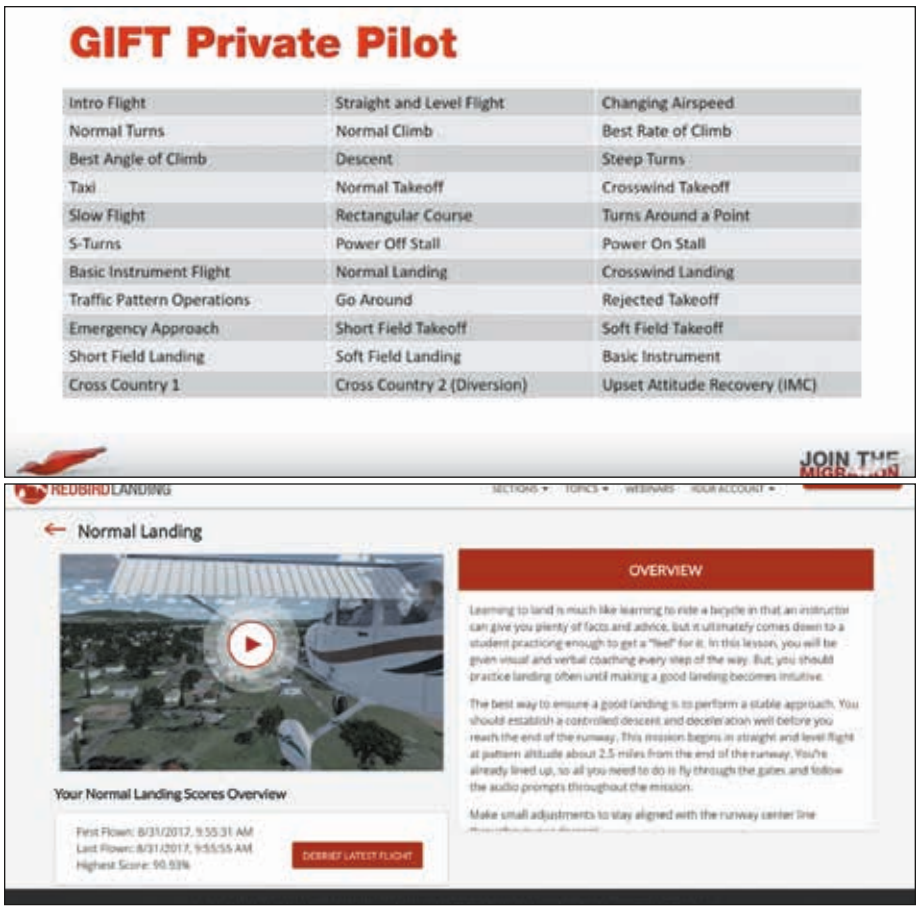
The system of instructor-directed, repetitive practice has worked for over 100 years and turned out some pretty impressive pilots from Dr. Jimmie Doolittle through Patty Wagstaff. However, given the sophistication of flight simulator visual displays, artificial intelligence technology and what we've learned about teaching people to fly, why can't a student do most of her maneuver repetition and practice time in a simulator being coached and evaluated by a computer program at less than half the cost of flight time

Some of Redbird GIFT's maneuver training modules involve flying the simulated airplane through gates in the sky to help the student visualize and fly the particular maneuver correctly.

CHECKLIST

- GIFT provides a strong introduction to each private pilot maneuver.
- Real-time verbal feedback speeds mastery of each maneuver.
- Non-expiring software license allows practice in any compatible sim.

The 33 Redbird GIFT maneuver modules for the private pilot certificate, top. Each module includes a surprisingly concise textual overview of the specific maneuver as well as a short video explaining it, bottom.



in a Hobbs meter-equipped airplane with a flesh and blood CFI?

EFFICIENCY AND COST

Instructional efficiency and cost drove Redbird Flight Simulations to develop its Guided Independent Flight Training (GIFT) program for students working on the private pilot certificate. What emerged from Redbird's R & D skunkworks was unveiled at OSH this year and is concisely described by Redbird as a "simulator-based maneuvers training supplement designed to help you achieve your goals faster and for less money."

GIFT is not a standalone training program. It was designed to be a ***supplement*** to any private pilot flight training program. It does so by being focused strictly on learning to fly the 33 maneuvers that must be mastered to become a private pilot.

After spending time going through a number of the individual maneuver modules and their written and video introduction to the specific maneuver, flying the maneuver in the simulator while receiving real-time coaching from the software and then having a detailed score generated within a few seconds, we came away impressed.

We've been involved in the flight training world for over 40 years and have observed that every single claim of "revolutionary" development or "game changers" or "the next level" in that world has turned out to be nothing but the product of the south end of a northbound bull. We have, however, during that time seen solid, real evolutionary steps that improved the quality, efficiency and effectiveness of flight training while helping to cut costs—notably in the early 1970s when Cessna developed integrated and standardized curricula through its Cessna Pilot Centers and, later, the introduction of good-quality video into flight training programs.

We think that because of Redbird's thoughtful integration of the objective standards of the new FAA Airman Certification Standards (ACS) for the private pilot certificate, high-quality visual displays in its flight simulators, artificial intelligence allowing real-time coaching and the ability to objectively score a student's performance of the basic private pilot flight maneuvers, we are about to see another evolutionary step forward in flight training. That's a big deal, in our opinion.

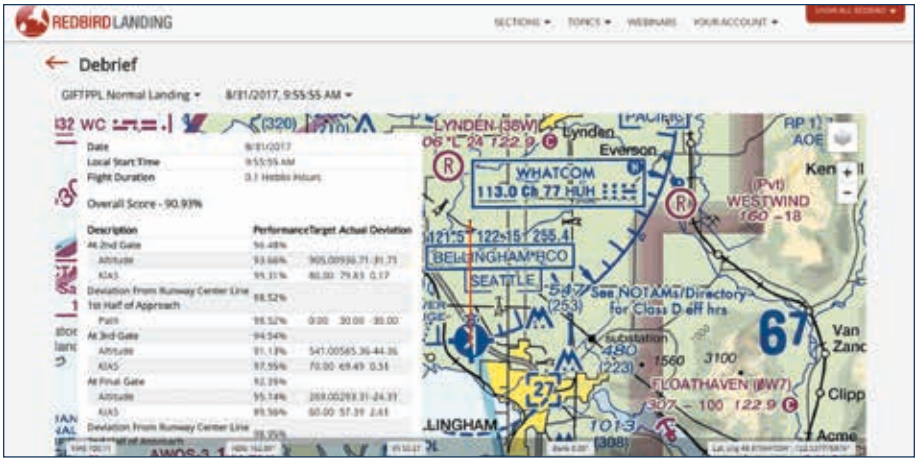
Because GIFT does not remove the CFI from the equation so much as it provides a CFI with an effective tool to train more students in a given amount of time as well as make more money for a flight school while—seemingly paradoxically—saving money for flight students, we think Redbird's GIFT can prove to be a good thing for all involved in the flight training world. We do note that active use of GIFT will probably result in a decrease in use of flight school aircraft per student, per rating—with an increase in simulator time. However, our research for this article indicated to us that flight schools make more money per hour from their simulators (low overhead) than from their airplanes even though they generally charge at least twice as much per hour for the aircraft than the sims.

HOW IT WORKS

For $249, a student purchases a license to use the Redbird GIFT software in any Redbird simulator in which GIFT is installed—currently all are Advanced Aviation Training Devices (AATD), although more basic sims are expected to be set up for GIFT. Right now the only airplane simulated is the round-dial and G1000-equipped Cessna 172. The Piper Archer is next up.

The license has no expiration or termination date—once it's purchased and operative, the student can use and review the text and video of the private pilot GIFT modules on an internet-connected device and practice flying the maneuvers in a Redbird sim. He can do so forever. After flying a number of the modules, we think that a few repetitions in the sim would help any pilot kick his skills up a notch in preparation for a flight review.

Josh Harnagel, Redbird's VP of marketing, explained that the GIFT modules exist to introduce students



Evaluation and scoring of one time through a maneuver—in this case a straight-in landing, top. Red line shows route flown. Text describes how close the approach and landing were to desired parameters at different points along the approach. It doesn't take much space—a Redbird FMX simulator capable of running GIFT installed in an office at Aspen Flying Club at Centennial Airport near Denver, bottom.

to the maneuvers in a distraction-free atmosphere. There is no holding short, number eight for takeoff with the Hobbs running—the student tells the simulator to start a particular module and whambo, the airplane is in flight, in position and configured to start the maneuver.

Flying most of the maneuvers takes less than five minutes and, once complete, the simulator pauses—and stops running up cost. The system generates an objective evaluation of the student's performance on the maneuver. It appears graphically—charting, for example, indicated airspeed, altitude and heading—and textually, comparing the student's performance to the ideal, and providing a percentage grade. 80 percent is passing, 90 is very good. Between 95 and 100 percent the scale becomes roughly exponential, making it extremely difficult to score 100—something Harnagel said Redbird learned from computer gaming as it has proven to be a powerful motivator to users. In one of our exercises, we kept the airspeed within 0.2 knots of what was called for and scored 99 percent, not 100.

The evaluation for each maneuver is kept on the student's account on Redbird Landing, a non-sales site that stores the student's GIFT module information. The student can share her scores with her instructor, to help tailor subsequent instruction in the maneuver in the airplane.

While a private student can log 2.5 hours of AATD simulator time (with an instructor) toward the certificate and a student using GIFT would be financially foolish not to do so, Harnagel pointed out that GIFT is not specifically designed for logging time, it is to teach the student to understand and fly the maneuver so that he can step into the airplane and demonstrate that he can fly it with a minimum of repetition in the airplane.

As an aside, GIFT deals with the problem of unsupervised students in a simulator seeing if they can do aerobatics or fly under bridges by simply returning the simulated airplane to straight and level flight if parameters of bank, pitch or speed are exceeded.

We did note that in trying the takeoff module, we were barely able to stay on the runway due to over-controlling the rudders and a lack of lateral Gs for feedback. Aspen Flying Club's assistant chief pilot Jon Nafi discussed our perception that the simulator was more difficult to fly than the airplane—and agreed. He pointed out that the student who learns a maneuver through GIFT in the simulator will generally find that it's easier to fly once she gets into the airplane, making for a positive learning experience and even more rapid mastery of the maneuver.

CONCLUSION

By coming up with a way for student pilots to engage in self-directed practice aimed at rapidly learning the maneuvers for the private certificate in a simulator, we think Redbird has taken the next evolutionary step in primary flight training in efficiency and keeping costs down. We understand GIFT for instrument rating maneuvers will be out next year. We'll be watching.

Garmin D2 Charlie: Nexrad, Better Maps

It's taken a few product generations, but Garmin's aviator watch is finally gaining real-world utility with weather radar display and better topo maps.

By Larry Anglisano

On the heels of our long-term report on Garmin's D2 Bravo aviator watch (March 2017 *Aviation Consumer*), Garmin releases the next version of the watch—the D2 Charlie. Into the long-term test pool it goes for an upcoming cockpit smartwatch shootout article, but in the interim here is what's new on the Charlie.

WEATHER ON THE GROUND

Garmin is trying to get as much mileage as it can from its watches by trickling models down into the aviation division and the D2 Charlie is a derivative of the successful Fenix 5 multisport watch series. The Charlie improves features we always thought could be better in the old pilot watch, which include more useful map graphics. There's still no touchscreen.

For us, the GPS-equipped D2 Bravo Titanium model (the new Charlie watch sits on the same Titanium chassis) proved better as a sports and biometric watch than a cockpit tool. Still, we use it to control Garmin's VIRB Ultra30 action cam on the fly, which is useful in our work. The new Charlie quickly connects with it and Garmin's new VIRB 360 camera—both at the same time. But you can do that through Garmin's VIRB and Pilot apps, too. The real reason for an aviator smartwatch is for viewing no-fuss, at-a-glance data. Mapping wasn't the best on the Bravo and Titanium, in our view.

But Garmin made it better on the Charlie by making it more detailed. It added bodies of water, highways, railways and more airports. The older Bravo's mapping really is stark by comparison even though the new Charlie uses the same high-resolution color display with LED backlighting. Battery life is around 20 hours when using the GPS and up to 12 days as a smartwatch.

New to the Charlie is a weather utility that displays Nexrad radar. The older D2 only displayed METARs and TAFs. No, it doesn't have a built-in weather receiver. It connects wirelessly to a tablet running Garmin's Pilot and the Connect app, or directly to a smartphone or tablet that's receiving cellular or internet data. This means it won't display real-time weather data in flight unless you have a cellular connection, although it will cache the Nexrad you've downloaded on the ground. If you're lucky, it will refresh if you descend into cell coverage. To access the local weather radar, press and hold the Direct-to and Down buttons. Pretty simple.

The D2 Charlie watch can be a source for watching the radar while preflighting or driving to the airport, as long as you have a cellular or internet connection on your smartphone. Notice its detailed topo map on the Titanium model in the main image.

We're surprised it won't display ADS-B or SXM weather through any of the various Garmin receivers (GDL39 ADS-B receiver and the new GDL51/52 SXM weather and ADS-B receivers, for example) when they're connected through Garmin Pilot. On the other hand, if you have a larger tablet display for showing the weather, we doubt the watch would have much utility as a cockpit weather display. But some might want it.

Like the older watches, the Charlie has Direct-to navigation, plus it overlays pilot-selectable navigation data fields over the map display should you want to navigate with it. It's not the best primary navigator, in our experience, but it works. New to the Charlie is airport information including frequencies, runway length and surface info and reported weather.

Outside the cockpit, the ability to connect with multiple devices at the same time, including cycling computers, has always been a strong capability for the D2 series and the Charlie continues to be a worthy sports watch and activity tracker. Like the Bravo Titanium, the Charlie has the Garmin Elevate wrist heart rate sensor that's slightly less accurate than a chest sensor. Other sport toolsets include golfing, swimming and skiing.

Two functions carried over from the Bravo and Titanium that we use are automatic flight logging (which is sent into the Garmin Pilot app's logbook utility), and smart notifications, where the watch identifies incoming phone calls and displays texts and emails received from a connected smartphone.

The D2 Charlie is $799 and comes standard with a leather band, while the Titanium version (with a titanium band) is $999. Both come with a silicone sports band, and all attach using Garmin's new QuickFit design—a big improvement over the old watch, in our view. Contact www.garmin.com.

LIFT Aviator Shoes: Comfort, Quality, Status

If you want performance shoes to wear with your flight suit, LIFT Aviation has plenty of styles. We think they offer some utility but wish all models were fire retardant.

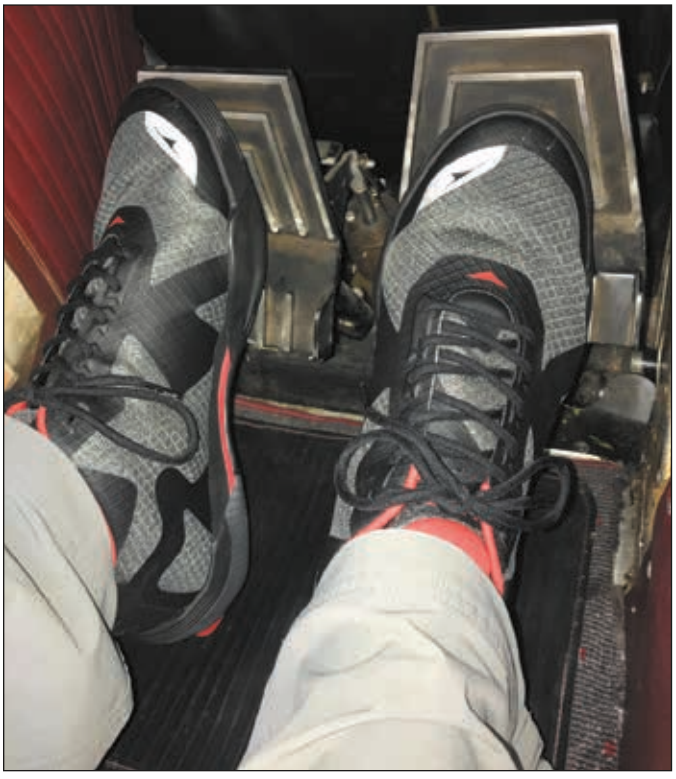
by Larry Anglisano

An acquaintance who pilots an MD 500 helicopter while barefoot says her bare feet on the pedals makes her one with the machine like no pair of shoes can. I get the need for feel, but to protect her toes, I suggested compromising with barefoot running shoes. I even stopped flying in shorts because I'm paranoid of a cabin fire.

Increased dexterity is partly the idea behind LIFT Aviation's line of aviator shoes, but safety and comfort are the primary goals. The company attracted attention at AirVenture this past summer, selling aviator shoes to pilots who didn't seem to bat an eye at the $119 starting price. To see if these shoes are for real, I ordered a pair and have been wearing them in and out of the cockpit for a couple of months. Here's a field report.

MOTORSPORTS ROOTS

LIFT is far from an industry newcomer. Its staff has been developing protective products for the extreme sports and occupational safety markets for over 30 years and the company president is a pilot. Early on, sister company EVS Sports (which designs and manufacturers the industry's largest line of motocross knee braces and body armor) made sizable inroads in the racing industry before LIFT Safety was created in 2006, followed by Lift Aviation. Some of LIFT's lead designers come from Alpinestars—a familiar name in motorcycling/auto racing apparel and protective gear. As a result, many of the shoes in the lineup resemble driving and motorcycle track shoes. LIFT also caters to law enforcement, military and the oil and gas exploration markets. Now it targets general aviation with several shoe styles at various price points, starting with the entry-level $119 Spinner, which LIFT puts in the casual shoe category.



Those are the $139 Air Boss sport-style shoes in the photo to the left. We wore them in a 100-degree cockpit and never got hot feet, thanks to their breathable insoles.

All of the shoes in the aviation line have LIFT's patent pending Flight System heel sliders, an injection-molded frictionless cleat set designed to keep your heels from getting snagged in the aircraft's carpeting or floorboards. In real-world ops, this could mean getting your feet on the toe brakes more quickly if you aren't quite positioned right on the pedals—which has happened to me after repositioning the seat while in cruise.

The shoes also have bilateral gripping (called G-Traction) that LIFT says is designed to make accurate and direct contact with the rudder pedals. While the shoes have an exceptionally narrow footprint that makes it less awkward to swing the feet into and out of the cockpit (I wore them while piloting a Skyhawk, a Cirrus and a Mooney), I couldn't notice a big difference in rudder pedal contact between the Air Boss sport-style model I tried and my Salomon trail running shoes that I usually fly with.

HIGH-QUALITY MATERIALS

One thing I did notice was the LIFT's sticky slip-resistant outsoles, which are also oil and heat resistant. If you do any wrenching, they can serve as comfortable hangar work shoes, minus much if any impact protection. One of the reasons I like to wear trail running shoes when flying is the increased traction when

CHECKLIST

- ⊕ A narrow sole, cleated heel sliders and rolled edges prevent dragging and snagging.
- ⊕ Lightweight construction makes them wearable all day—good for flight crews.
- ~ Fire retardant models are premium priced and available in black only.

LIFT SHOE CONSTRUCTION AT A GLANCE

** DAKOTA MODEL SHOWN*

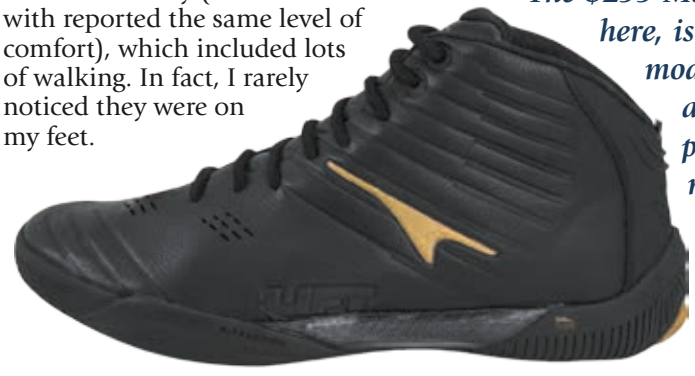
climbing around and jumping off the wing, for example, and the LIFT shoes are about the best I've worn for anti-slip performance—wet and dry. If you fly something where you have to climb on the structure to check fluids and perform other duties, these shoes might keep you from falling off.

Speaking of falling off—and in—I wish the minimalist sport models were waterproof for seaplane flying. If you fly off the water you know your feet are sure to get wet. I wouldn't want to completely submerge the Air Boss shoes I tried in fear of long-term water damage to the insoles.

As for comfort, LIFT nails it and that's partly because of the highly cushioned sole that allows for increased flexibility in the toe area, but stiff support in the heel—a potential stress point in other shoes. I had no problem wearing the Air Boss model for an entire day (others I talked with reported the same level of comfort), which included lots of walking. In fact, I rarely noticed they were on my feet.

All models have machine washable and lightweight OrthoLite insoles, a third-party brand that's popular in other high-end shoes (including Nike, Salomon, Rockport and New Balance, to name a few) and the memory foam technology helps the insole maintain nearly the same level of cushioning and fit over a period of time. OrthoLite's open-cell foam is advertised as being nearly 100 percent breathable and it is indeed effective. In the hottest conditions, my feet never sweat in the Air Boss shoes while wearing a high-quality sport sock—which is not the case with my trail runners.

The $139 Air Boss is available in three colors including black/red, grey and a lighter grey with yellow accents. The other sport-style shoe is the $169 Talon, constructed with LIFT's Response Core carbon fiber midsole for stiffer mid-foot stability. It's available in black/red, black and blue. Most of the sport and casual LIFT shoes are sized smaller than a typical dress shoe and the company suggests ordering one size larger than your ordinary shoes. This advice was spot-on for me and yielded a perfect fit.



The $299 Merlin, shown here, is LIFT's flagship model and aimed at professional pilots. It has Nomex laces and is fire retardant—which other models lack.

UNIFORM SHOES

LIFT says pro aerobatic pilots prefer the two stiffer models, which include the aforementioned Talon and also the flagship Merlin, which is also marketed to professional pilots who have to wear black shoes as part of a uniform. One Merlin model is a so-called commercial version that's black, has a fire-resistant Carbon X liner, high-heat rubber outsoles and Nomex laces. It has a perforated Clarino liner and insole, plus a carbon fiber midsole.

If you fly in a uniform or business attire, you might get away with wearing the $189 Dakota model—an all-leather shoe that comes in brown or black.

LIFT sells its shoes directly on its website (www.liftaviationusa.com) and through Sporty's, Aircraft Spruce, Pilot Mall and Mypilotstore.com. Contact LIFT Aviation at 262-394-5370 in Walworth, Wisconsin.

Model 35 Bonanza

Thanks to a long production run and an owner base that spends big on mods and maintenance, the venerable V-tail Bonanza is a good used market buy.

If Beech Bonanza ownership seems out of the budget, the good news is that there are plenty of vintage V-tail models on the market at affordable prices. The bad news is that unless those 50- and 60-year-old airframes have been well maintained, you could be buying a money pit. Plus, shops won't feel sorry for you when you roll up in any Bonanza.

Not that an old V-tail restoration is bad thing. Many owners throw endless amounts of money at these airplanes making them far better than new. Pick your vintage. With antecedents dating to 1947, the venerable V-tail remained in continuous production until 1982, something no other model can claim.

Although not cheap to operate, they aren't unreasonable, either. Parts and support remain easily available, although owners concede parts can be expensive because, well, it's a Beechcraft.

Although the V-tails suffered a bad rep thanks to a series of breakups during the 1980s, there's little concern today. These airplanes have been subjected to a Beech-developed tail beef-up kit that has all but eliminated the breakup issue, although we found some broken airframes in the NTSB reports that were clearly no fault of the airplane.

On the used market, the P35 is one of the best values perhaps because of its redesigned instrument panel.

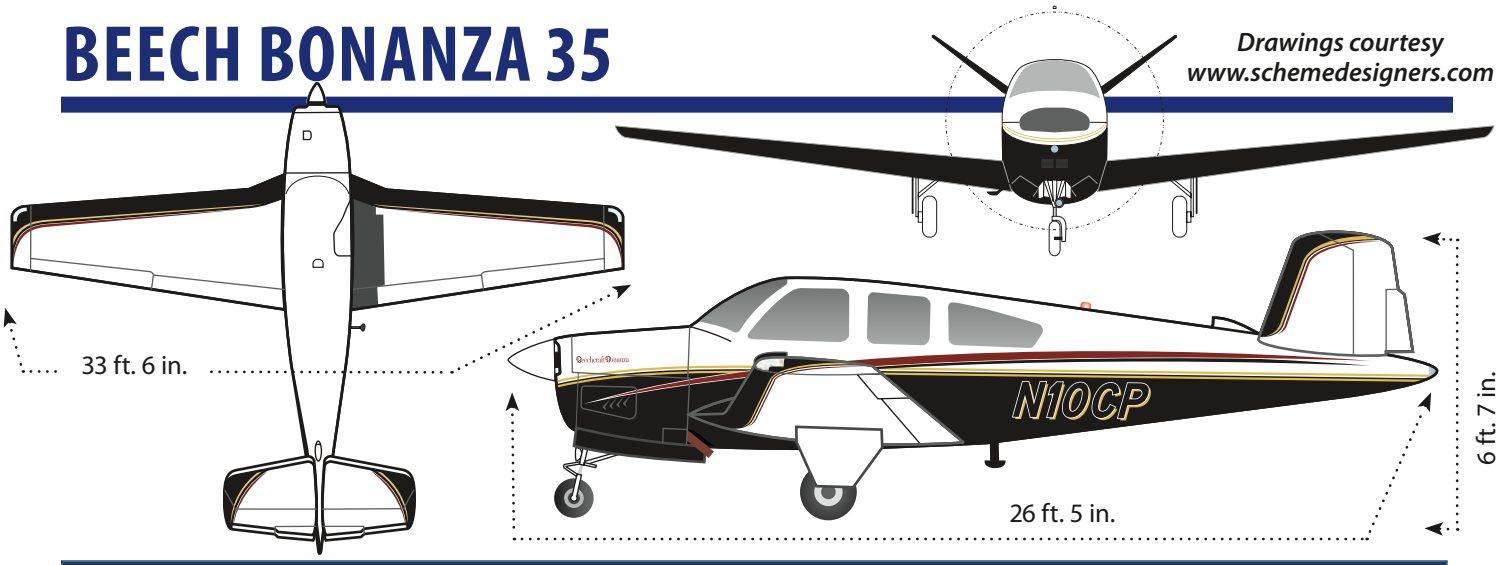
MODEL HISTORY

The first V-tail Bonanzas were so ingeniously conceived that it appears they sprang from the mind of designer Ralph Harmon and others full-blown in the dim past of 1945. At the outset, the airplane was like nothing else on the market: fast and slick and great looking. The basic format was retained for decades through fine-tuning, strengthening and bigger engine iterations, yielding a plethora of model designations and no shortage of mods. In keeping with Beechcraft's reputation for excellence, the early Bo's got the benefit of wind tunnel testing and study to find ways to boost speed and increase safety, something not commonly done in the 1940s. This shows in the details, such as fully retractable tricycle gear, with no projecting bumps or humps as on some other aircraft, and extensive use of flush-riveting. A unique fuselage design incorporates a sled-like keel arrangement and box structure to increase crashworthiness.

That's Rick Johnson's 1960 M35 cruising in the lead photo. In Canada, Johnson says, the airplane is unique because there just aren't many flying.

BEECH BONANZA 35

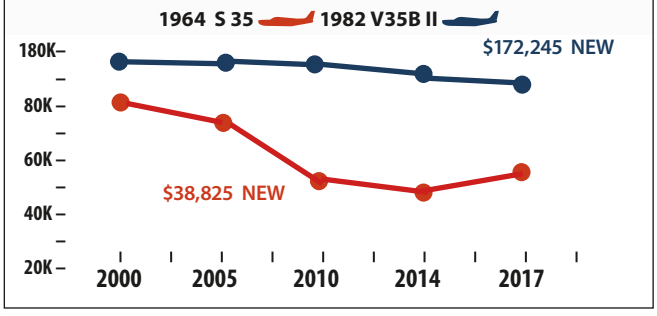
Drawings courtesy www.schemedesigners.com



SELECT MODEL HISTORY

MODEL YEAR	ENGINE	TBO	OVERHAUL	FUEL	USEFUL LOAD	CRUISE	TYPICAL RETAIL
1947-1949 BONANZA 35	CONT. 185-HP E-185	1500	$30,000	39/60	1092 LBS	150 KTS	±$18,000
1949-1950 A,B 35	CONT. 185/196-HP E-185B	1500	$30,000	39/60	1075	148	±$20,000
1951-1953 C,D 35	CONT. 205-HP E-185-11	1500	$30,000	39/60	1050	152	±$23,000
1954-1956 E,F,G 35	CONT. 225-HP E-225-8	1500	$30,000	39/60	1053	160	±$32,000
1957-1960 H,J,K,M 35	CONT. 240/250-HP O-470	1500	$30,000	49/70	1118	170	±$41,000
1961-1963 N, P 35	CONT. 260-HP IO-470-N	1500	$30,000	50/80	1270	170	±$46,000
1964-1965 S 35	CONT. 285-HP IO-520-B/BA	1700	$30,000	50/80	1385	178	±$54,000
1966-1967 V 35	CONT. 285-HP IO-520-B/BA	1700	$30,000	50/120	1485	177	±$59,000
1966-1967 V 35-TC	CONT. 285-HP IO-TSIO 520-D	1400	$30,000	50/120	1450	195	±$64,000
1968-1969 V 35 A	CONT. 285-HP IO-520-B/BA	1700	$30,000	44/74	1440	177	±65,000
1968-1969 V 35 A-TC	CONT. 285-HP IO-TSIO 520-D	1400	$30,000	50/120	1373	200	±$73,000
1970-1976 V 35 B	CONT. 285-HP IO-520-B/BA	1700	$30,000	74	1450	172	±$89,000
1977-1982 V 35 B	CONT. 285-HP IO-520-B/BA	1700	$30,000	74	1450	172	±$115,000

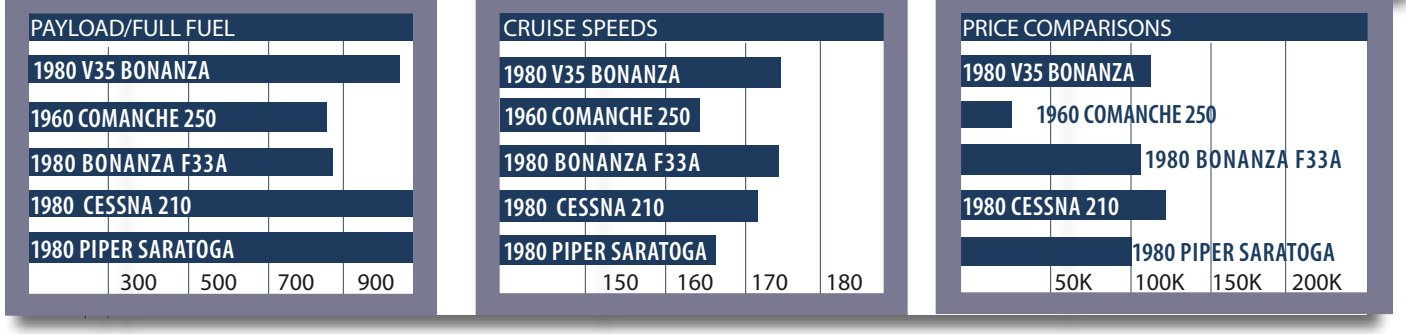
RESALE VALUES



SELECT RECENT ADs

AD 97-06-11	RUDDERVATOR CONTROL ASSEMBLY
AD 94-20-04R2	TAIL MODIFICATION (REVISED)
AD 76-05-05	STABILIZER ATTACH FITTING
AD 75-15-08	ENGINE LUBRICATION
AD 72-11-02	ENGINE FUEL INTERRUPTION

SELECT MODEL COMPARISONS



Interior upgrades for aging Bonanzas are common. Those are new leather seats in the V35 at the top. Notice the quick-release passenger window in the inset. Extended-range tip tanks give the airplane long legs, bottom.

This structure extends into the engine compartment, with the motor mounted on keel extensions, making it easy to access for most maintenance operations. We've always liked that the huge side windows were hinged at the top with quick release openings at the bottom to allow easy escape in an emergency, a side benefit enjoyed by rear-seat passengers.

THE FAST STRAIGHT 35

The first so-called "straight 35" model Bonanza had a 165-HP Continental engine that produced an amazing 175 MPH at cruise speed. These models are among the cheapest Bonanzas on the market these days, but we would counsel potential buyers to be cautious. Unlike later models, the straight 35 lacks a shear web in the main wing spar—a design strategy undertaken to save weight. And although Beech offered a 35 wing-strengthening conversion in 1951, there weren't many takers for the expensive mod, priced at $6000.

Beech offered a number of wing mods and there was an aftermarket modification called the Jourdan-Flannagan mod. Some advise avoiding these, but if you're considering one, the American Bonanza Society believes they can be operated safely if you do your homework. That means a careful prebuy inspection and a checkout that emphasizes operating limitations.

With the succeeding A35, Beech made important strengthening improvements, adding a new wing carry-through structure and thicker wing skins and fuselage stringers. They beefed up the fuselage bulkhead at the tail attachment. On the B35, a slight power boost during takeoff of 11 HP was engineered through slightly higher RPM. With the C35, major changes were made to the stabilizer. The chord was increased by 14.4 percent and the dihedral increased slightly in an attempt to reduce yawing. The chord increase was made by simply extending the leading edge, but leaving the front spar where it was.

This created a greater overhang forward of the spar that would figure in tail-twisting during in-flight breakups and would later be secured by a bracket after a big FAA/Beech investigation into the breakup problem. With the E35, buyers had the option of a 225-HP Continental engine. Also, aileron trim was added for the first time and back-seat passengers got a couple inches more legroom.

The magnesium flaps were replaced with aluminum ones. In the G35, the wing was beefed up once again. And gear extension speed went up from 125 to 140 MPH, the first in a series of speed boosts that would make the landing gear an effective speedbrake.

MODERN BONANZAS

The H-model represents what Larry Ball in his book, "The Incomparable Bonanzas," calls the beginning of a second generation of Bonanzas. The airplane got a bigger 240-HP powerplant which, for the first time in the line, offered identical takeoff and max continuous horsepower. This was the first wet sump design for the Bonanzas, allowing oil to be carried internally rather than in a separate oil tank, thus simplifying the plumbing somewhat. Additional strengthening was also added to the tail, fuselage and wings.

The major change on the J35 was a switch to a 250-HP fuel-injected engine. On the K35, the standard

The V35B panel to the right has Avidyne's STC'd DFC90 autopilot retrofit, along with an Aspen PFD. Al Boyce's K35 panel, middle, has early-2000s vintage Garmin-AT avionics and an S-TEC 55X. Not much of that will fit in early "piano keys" panels, bottom.

fuel capacity was boosted from 40 to 50 gallons, which with the 20-gallon aux tanks gave 70 gallons and moved the airplane up into the serious cross-country machine it is today. Also, an optional fifth jump seat was offered, allowing more chances to load aft of the weight-and-balance envelope. Throw it away is our advice and many owners seem to agree.

Elongated, curved rear side windows were added to the N35. Horsepower went up to 260 and fuel capacity rose to 80 gallons, while the number of fuel tanks was reduced to two. This was done by offering optional 40-gallon tanks in place of the standard 25-gallon tanks. Along with "full-time" fuel quantity gauges provided to both tanks, fuel management was simplified, a good safety feature.

The addition of new, long leading edge fuel tanks displaced wing landing lights, which in turn were moved to the nose and nosegear strut, where they remain in modern designs. Landing light bulb replacement is thus among the easiest of all GA models. And yes, LED lamps are the proverbial fish out of water on a vintage V-tail.

Pilots concerned with tracking troublesome magnesium components might also note the ailerons were converted to aluminum, thus easing repairs and repainting somewhat.

On the used market, the P35 is one of the best values, perhaps because it got a completely redesigned instrument panel, with the famous "piano keyboard" switch arrangement of the early models abandoned in favor of conventional switches, albeit not always located in the best places along the lower panel eyebrow.

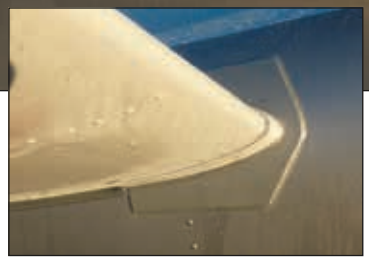
The P-model saw a higher landing gear extension speed, up from 140 to 165 MPH. Although the P-model was a large step forward, Beech had even bigger ideas.

The S35 Bonanza got a 285-HP powerplant and a longer cabin with a new aft window shape like that found on Barons. The aft bulkhead was moved back 19 inches and although this made for a comfy cabin, it planted the seed of what has become a chronic complaint among Bonanza owners: aft CG. To address that in the S-model, Beech added a 25-pound lead weight to the nose for balance.

Theoretically, the S-model was a six seater. But not really. It's just not practical to stuff passengers back there, unless they're lightweight kids. The larger baggage compartment door is a nice plus, however. Visibility out front improved with the V35 model as a one-piece windshield was made standard. And on the V35A that followed, a bigger, swept windshield was added that allowed more space behind the instrument panel for maintenance.

A V35TC turbocharged model was added to the line for the first time, also. Normal gear-down speed went from 165 to 175 MPH. The big safety improvement on the V35Bs was the addition of anti-slosh fuel cells to prevent inadvertent unporting during slips, skids and turning takeoffs, a shortcoming that had caused mishaps.

Some models carry placards advising of minimum takeoff fuel,



If you can't afford an IO-550 conversion, the next best choice is the IO-520 (top), found in the S-model forward. For the power, it's one of the most economical GA engines available. That's the tail reinforcement mod in the lower photo. At this point, it's tough to find a V-tail that hasn't been modified.

but many have anti-slosh baffles to address this.

PERFORMANCE

Bonanzas are famous for their speed and justifiably so. With the largish engines and relatively low drag, owners report cruise in the 150- to 175-knot range, depending on engine power. The real eye opener with regard to raw speed is the conversion to a Continental IO-550 engine.

That speed comes at a price, however. Like Mooneys and other high-performance airplanes, the Bonanza is slick and will build speed quickly in a dive or an upset; thus it requires attention from the pilot in instrument conditions or potentially moderate turbulence. Bo pilots are wisely taught the desperation tactic of lowering the gear to arrest an out-of-control dive or unusual attitude.

Anyone who has stepped into a Bonanza from another model is immediately impressed with how well the V-tail (and straight tails) handle. The controls are silky smooth and light with nearly perfect harmony between aileron and pitch pressure.

However, the stick-forces-per-G are also light, which means that the ham-fisted pilot has less margin in turbulent air. Even with the tail mods, the airframe can still be bent.

As with any high-performance airplanes, landings require good speed control. Although they can be done power off, most pilots seem to fly the approach with just a bit of throttle to improve ruddervator response and avoid sink fests. Consistent, smooth touchdowns are achievable but, more to the point, screwing up a landing in a Bonanza is hard to do. It doesn't have the Mooney's vicious porpoise or the Saratoga's tendency to plop.

What it does have is the famous Bonanza tail waggle in turbulence, which is bound to make backseaters with tender stomachs somewhat queasy. Oddly, many believe the tail waggle is unique to the V-tail, but the straight-tail 33s have it too. Some owners ignore it; some say a yaw damper is required equipment, and many airframes have them installed.

LOADING

Apart from the tail waggle, passengers give Bonanzas high marks. For one thing, there's plenty of shoulder and head room; the interior feels more like a 1950s Chevy than the cramped interior of the typical high-performance single. The front seats are relatively upright and comfortable, but lack much forward and rearward adjustment.

Legroom is adequate in both front and rear seats. By GA standards, the giant windows give unmatched airiness and visibility, especially out the rear side windows and forward through the windshield.

When carrying passengers, Bonanza pilots learn to brief them carefully on closing the cabin door. Most pilots do it themselves, for if not properly secured, the door is almost certain to pop open on rotation. It's not an aerodynamic hazard to further flight, but can be dangerously distracting. It's happened to us several times.

The aircraft's loading Achilles' heel is its relatively narrow weight and balance envelope, a peccadillo owners gripe about. Even without big-butted passengers, it's easy to load aft of the rear CG, a potentially nasty situation in any airplane, but doubly so in one with controls as light as those on the Bonanza.

And on later models, as fuel burns out of the leading edge wing tanks, the center of gravity shifts farther to the rear, aggravating the situation. V-tail Bonanzas have generally stricter rear CG limits than the straight-tail models, which means that the same load will put you a lot closer to the aft limit in a V-tail.

WRENCHING IT

Buyers should be alert to three main problem areas: damaged control cables, rods and fittings; malfunctioning, out-of-order landing gear components; and corrosion. The landing gear and corrosion problems can be especially expensive to repair.

There's also the tail inspection that's required by Beech Aircraft Corp. as part of the tail-brace installation. Obviously, the tail fix will have been completed more than 20 years ago, but that doesn't mean corrosion will stop.

The airplane should be inspected carefully. Proper ruddervator balance has always been a critical matter on the V-tail Bonanzas to prevent flutter or vibration, which can contribute to severe structural damage and even inflight breakups.

We found more than one of these incidents in our recent scan of accidents. The balance margin is so narrow that unbalancing could result from repainting the ruddervators without rebalancing afterward. Most

No matter the vintage, a close look at the landing gear during a prepurchase inspection is a must. Corrosion and rigging issues aren't uncommon.

shops know all about this, but some still make the error anyway.

Corrosion is often encountered with magnesium components like the ruddervators and on some Bonanzas, the flaps and ailerons. But check other components as well, as the Bonanza fleet ages. Some corrosion may have been well hidden. The 35 series is not exactly slammed with ADs, but a prospective buyer should check the list carefully, especially the tail fix AD.

MODS, OWNER GROUP

A lot of mods are available for Bonanzas, from STOL kits (Innova Aerospace, www.sijet.com) to engine swaps (D'Shannon Aviation's IO-550, www.d-shannon-aviation.com), to speedbrakes (Precise Flight, www.preciseflight.com) to TKS anti-ice systems from CAV Aerospace at www.caviceprotection.com. D'Shannon also offers vortex generators, which are a worthwhile investment. Speaking of things worthy, the American Bonanza Society provides a good-looking four-color magazine, plus lots of technical advice. It sponsors pilot training and maintenance clinics around the country through its Bonanza Pilot Proficiency Program.

We would consider membership in this group a must for Bonanza owners, but especially any owner new to the airplane. Paul Damiano, the organization's current president, is a longtime owner of one of the best-kept N35 models we've seen and he's our go-to for anything related to these airplanes. Contact the ABS at 316-945-1700 or www.bonanza.org.

OWNER FEEDBACK

I have owned N637Q, a 1959 K35 Bonanza, for 40 years. I love flying this nimble, reliable and well-designed aircraft and would recommend it as an upgrade to anyone who has attained solid flying skills in a less complex machine. Most Bonanza owners take pride in maintaining and upgrading their aircraft and with many owners now senior, expect to see fine examples in the used market.

The K35 is powered by an IO-470-C with 250 HP and is one of the most trouble-free of the big Continentals. I flight plan for an overall fuel burn of 14 GPH running 75 degrees rich of peak EGT and plan on 160 knots TAS.

Basic annual inspections run between $2000 and $3000 depending on how well you take care of things in between each event. Insurance cost varies greatly and depends mostly on pilot experience and the coverage you select. A yearly premium

V35 BONANZA CRASHES: ENGINES

Our review of the 100 most recent crashes of Model 35 Bonanzas revealed good news—there were remarkably few runway loss of control (RLOC) events—and not-so-good news—there were quite a few catastrophic engine failures and a surprisingly high number of fuel-related engine stoppages.

Only eight RLOC accidents is strong evidence of good ground-handling characteristics of any airplane—for nosewheel airplanes the average is closer to 20. There were also very few overshot landing accidents. We expect to see about five; there was only one. Three pilots aborted takeoffs—the cabin door popped open on all three—and couldn't get stopped.

Twenty-two engine stoppages is about what we expect to see; however, what we didn't expect to see was that over half were catastrophic events resulting from improperly conducted maintenance or overhauls. One of the lack of maintenance accidents involved an engine that seized due to lack of oil—the top of the engine oil filler neck had corroded so badly that it broke off, leading to the oil loss.

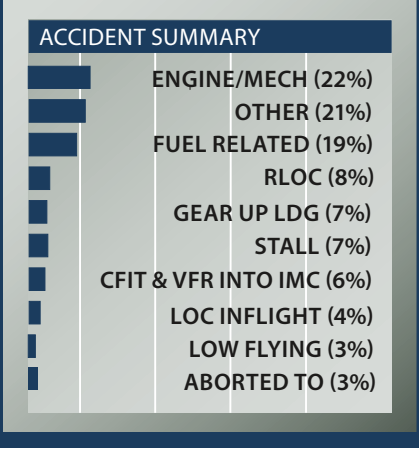
Amazingly, two of the pilots who experienced engine failures while talking with ATC did not tell the controller that they had an emergency nor the nature of their problem. As a result, they did not get vectors to the nearest airport by the most direct route, resulting in-off airport landings.

There were 19 fuel-related accidents—an unusually high number. Not only did a few pilots run their airplanes out of fuel completely, several ran a tank dry and didn't change tanks before completing the resulting glide to the ground. At least three pilots pointed the fuel selector to a spot between the right and left tank positions. As a result of these accidents, we think pilots should pay special attention to the fuel selector and assure themselves that they know exactly how to position it to draw from each tank. It is apparently not intuitive as the rate of fuel-related accidents is well above what we expect to see on other airplanes with multiple fuel tanks.

We also note that some Bonanzas can have as many as six fuel tanks and may have an indicating system that points to only one tank at a time—not necessarily the one from which fuel is being drawn. One accident was the result of a pilot new to an airplane set up in that fashion. He ran one of the tanks dry but had fuel in some of the others.

There were three inflight break-ups. Two were due to loss of control; the third was because the pilot was descending at near redline speed in turbulence. Two airplanes experienced structural failure but remained whole long enough for safe landings. One pilot was head down "cross checking and calibrating" the multiple GPS units he had installed. When he looked up the airplane was in a 75-degree bank and 20 degrees nose down. He rolled and pulled—and bent the fuselage. The other hit severe turbulence and deformed the airframe.

We applaud the judgment of the FAA inspector who, when faced with a pilot summoned for a recheck of his ability to fly, elected to watch from the ground. The pilot hit so hard on landing that he blew a main gear tire, damaged the gear and lost control of the airplane, running off of the runway.



might be between $1500 and $3500. A hangar is highly recommended to keep the airplane out of the weather.

There are many excellent STC'd mods available for the V-tails, which I would recommend a potential buyer look for when searching for an airplane. Some popular mods include a speed-sloped windshield and thicker side windows with opening vents, extended-range fuel wingtip tanks, GAMIjectors, an air/oil separator, dual control yokes, Cleveland wheels and brakes, a spin-on oil filter adapter, a firewall-mounted battery box and shoulder harnesses. Parts are generally available from a variety of sources, although some are quite pricey.

A must is a prebuy evaluation by a Bonanza-savvy A&P or IA mechanic. Buying blindly could easily generate a $10,000 annual inspection invoice. If an inspection at an ABS Service Clinic can be coordinated before purchase, it might be the best money you could spend. There is tremendous organizational support for all Bonanza and Baron models through membership in the American Bonanza Society—another must, in my view. The monthly magazines are a tremendous source of Bonanza information.

Al Boyce
Coronado, California

I've owned C-FNTI, a 1960 model M35, since 1988 and it presently has approximately 3600 hours total time. The only real problems that I've had with this airplane have been engine related, otherwise I've found it to be relatively trouble-free but that's probably due to the fact that I don't let small problems become big, expensive ones.

It was painted in 1993 and has always been hangared so the paint is still good. For upgrades, I've done most of the popular ones such as the BDS speed-slope windshield, thicker side glass, S-TEC autopilot and GAMIjectors, plus my mechanic did a partial panel modification that gave me a modern layout with the radio stack on the right, but it also retained the original "piano key" switches. I installed an Aspen Evolution PFD and the radios are the familiar Garmin GNS430 and BendixKing KX-155. I use a Garmin

496 portable GPS for XM weather and entertainment.

When the engine was overhauled roughly 14 years ago, it was rebuilt as a 260-HP IO-470-N. This allowed me to keep the Beech prop; the original prop was on the airplane until four years ago when I was able to replace it with another Beech 278 prop. Barring exceptional years (like 2017) when engine work is required, I seem to average between $16,000 and $20,000 per year for routine costs. This includes insurance ($1350 for $90,000 full coverage), fuel, routine maintenance, hangar costs, charts and electronic nav data.

This year will be more because I had to top all six cylinders due to worn guides and burnt valves. I pay particular attention to the landing gear to make certain that it's properly set up. I make a point to go at least once a year to a specialty Bonanza shop, including Avstar Aircraft at KPLU airport. Also, anyone who buys a Bonanza or is even thinking of one must join the ABS in order to be informed about the airplane's nuances.

For performance, I generally see 165 knots true on 11 to 11.5 GPH fuel burn. It's a great four-person airplane with no baggage, or two people with bags. It has two 25-gallon main tanks and two 10-gallon auxiliary tanks for a total of 63 gallons of useable fuel. This is enough for more than 4.5 hours, which is about right for me.

It's said that the V-tails have a very limited CG envelope and although that's true, because the 1960 and earlier airplanes have relatively small luggage compartments, the ability to load items a long way aft is restricted. Consequently, I haven't encountered CG constraints. My wife and I can load our folding Dahon bikes by putting one in the luggage compartment and one on the rear floor.

In short, it's reasonably fast, it's comfortable, the fuel consumption is reasonable, it carries all that I need. Plus, since there aren't many Bonanzas in Canada, my airplane is slightly unique.

Rick Johnson
via email

I jointly added a 1955 F35 Bonanza to my plane collection about 18 months ago with a partner who is new to flying. I currently own an Aerostar so my eyes were wide open when we pulled the Bonanza purchase switch. Our plane, N435WM, was a largely unmodified airplane all the way to the piano keys and the non-standard six pack panel. The airframe itself was in excellent condition that belied its 62-year-old age. The plane was last painted in 1994 and by anyone's account it still looks new. The inside of the tail looks like a fresh beer can and all of the original production stencils were still present on inside of the aluminum skin. This plane had the potential to be a museum piece.

The prior owner was budget conscious to a fault and the hose connecting the accessory case oil drain to the intake looked like a soft sponge. The plane had been maintained by an A&P in a small fly-in community who clearly was not up to my level as there were a lot of "we are monitoring that" answers. Believe it or not, when we purchased the airplane the engine and cylinders (an E225-8) had made it from 1965 to 2016 without as much as a cylinder being replaced. Despite being approximately 200 hours past TBO the old E-series engine purred and the compressions were excellent. We bought this very nice airplane for $30,000 and flew her off the field a few days later. It was my partner's first aircraft purchase and he could see no fault with this shiny new airplane.

Unfortunately that is where the good news ended as what seemed like a minor oil leak in a plane that had only flown 13 hours in the last year metastasized in just a few hours from a nuisance to unsafe. Within six months of the purchase, and another 25 hours, we were losing or burning a quart of oil every 90 minutes and the belly of the plane had enough oil on it after each flight that I was no longer comfortable in it. It was clear that this plane, in my opinion, was no longer airworthy and needed a complete firewall-forward engine. My partner, who still did not even have his private pilot's license, was still so green that he thought this would be done in about six weeks and that a new motor was available just for the asking.

Never shying from a good proj-

The Aviation Consumer

35 BONANZA

(continued from page 31)

ect, we removed the engine and the electric prop. Having now done this I think I can remove the engine in four hours—especially if you have a good automotive engine hoist and some wooden A-frame. The engine was rebuilt by Poplar Grove Airmotive, who was one of the few companies in the country with credible expertise in these antique motors. We crated the electric prop and sent it off to Stockton Propeller to have it rebuilt and restored to a like-new appearance. There was no shortage of the "while we are in there" issues so we had Bogert Aviation build a new harness, another vendor rebuilt the gear motor, we replaced all of the electric solenoids and polished out the engine compartment. At the end of the day we ended up with the closest thing to a new 1955 Bonanza that I could imagine.

The project is not one for the faint of heart or the thin pocketbook. The rebuild of the engine and prop together with all rebuilt accessories cost well in excess of $50,000 and that was before any money was spent in labor. By my estimation the restoration took about 300 hours and realistically took from Thanksgiving 2016 until May 2017 before the plane was flying again. I can say that we could have done it faster but this was a project that I was tackling in my own spare time.

Some additional credit is owed to the Beechtalk community as there are a number of good sources of armchair advice available. With that said, you have to be careful who you listen to as I also found that some of the posters fill the forum with completely false information.

We flew the plane about 15 hours before I would release my partner to begin his training in it. In the 15 hours we experienced the typical problems you find with any firewall-forward rebuild. One of the Garlock seals on our fresh engine was damaged when Poplar Grove assembled the engine and oil was leaking out of the fuel pump accessory drive adapter.

Our prop apparently came back from Stockton missing a washer around one of the counterweight bolts, so the prop worked great for about 10 minutes until the weight rotated and the vibration started. We returned to the field and found the obvious problem. The folks at Stockton appropriately apologized and overnighted the missing washer and the problem was immediately solved. Both Stockton and Poplar Grove clearly stood behind their work—albeit on my labor.

Eric Lipper's 1955 F35 sits on jack stands as it waits for an overhauled engine.

I originally told my new partner to be a renter, but he needed to own an airplane. From a financial perspective this was a huge mistake and the numbers will never make sense, but we do have the joy of knowing that N435WM has to be one of the best unmodified F35 Bonanzas out there.

Once you fly one of these old V-tails you will appreciate the genius of the design and the quality of the construction. In addition, you can park it next to a new Cirrus and most people will walk right past the composite airplane to revel in the coolness of the Bonanza and inevitably ask how that V-tail works.

Eric Lipper
Houston, Texas

FEEDBACK WANTED

MOONEY M20J/201

It's time for a fresh look at the Mooney M20J/201 market in an upcoming Used Aircraft Guide in *Aviation Consumer*. We want to know what it's like to own these aircraft, how much they cost to operate, maintain and insure and what they're like to fly. If you'd like your Mooney to appear in the magazine, send us any photographs (**full-size, high-resolution please**) you'd like to share to the email below. We welcome information on mods, operating expenses or any other comments. Send correspondence by November 1, 2017, to:

Aviation Consumer
Email at:
ConsumerEditor@hotmail.com